A CONCISE COURSE IN
SCIENCE
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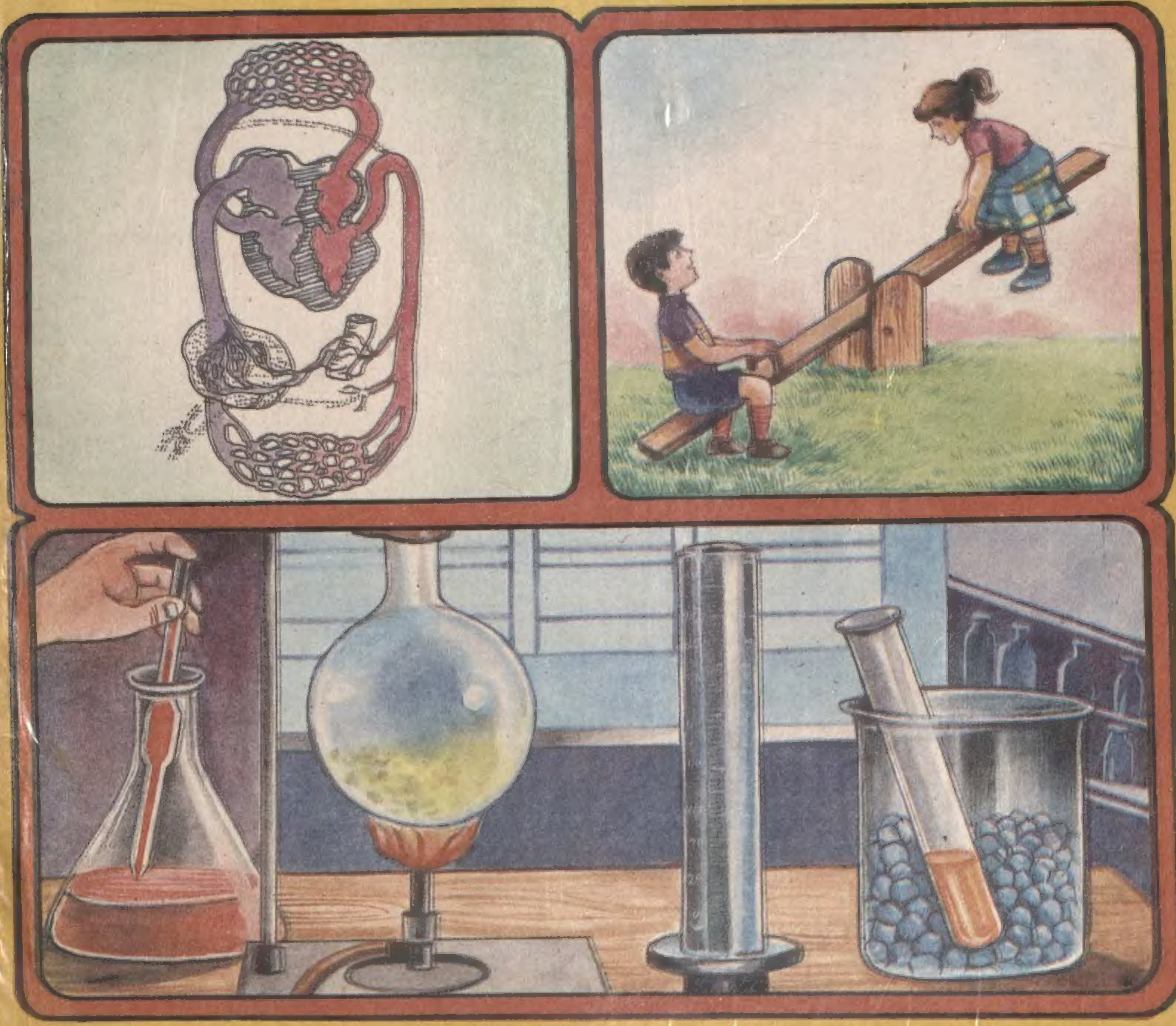

BASED ON THE NEW SYLLABUS IN SCIENCE PREPARED BY N.C.E.R.T., NEW DELHI, UNDER THE NEW EDUCATION POLICY

A CONCISE COURSE IN SCIENCE

BOOK III

(For Class VIII)

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PREFACE

It is considered necessary to initiate a new approach to the study of science at the school level. At present the emphasis in Science teaching is on the pupil making discoveries by investigation and on the understanding of the concepts rather than on the memorization of facts.

The new approach to the study of Science demands the active participation of students in the learning process through experimentation. This approach leads to a proper understanding by the students of the basic concepts of Science and enables them to discover new ideas.

The efforts of the authors have been to relate, as far as possible, the teaching of Science to what a student sees and does in everyday life. The thrill and excitement of doing experiments help the student to understand the subject and find something new for himself. Students are curious; they search to understand the unknown and so an interest in learning develops. Efforts have been made here to involve the pupil, physically and emotionally, to make the learning of Science a personal experience.

This series has been designed to meet these needs. It fully covers the latest syllabus in science prepared by the N.C.E.R.T. under the New Education Policy. The language used is simple and concise. The text has been attractively illustrated with many clearly labelled diagrams. Carefully planned out questions are given in the text to teach the pupils to reason and to arrive at logical conclusions. A large number of *Objective type* and *Short answer questions* have been included to help the students in self-testing. A number of new diagrams make the matter self-explanatory. The experiments and activities have been carefully designed to fit naturally into their enquiry and are such that every teacher and student can perform without difficulty.

The authors would feel happy if this book could satisfy the needs of the students of the middle school classes and help them to understand and appreciate the applications of the Fundamentals of Science in everyday life. Suggestions for improvement of this book would be gratefully accepted from fellow science teachers, students and parents.

—Authors

CONTENTS

CHAPTER 1

CARBON AND ITS COMPOUNDS

Symbol : **C**

1.1 Carbon in Nature

Carbon ranks twelfth in the order of abundance among the elements present in the earth's crust. Although it makes up only about 0.12 per cent of the earth's crust by weight, it is one of the most widely distributed elements. All living things–plants and animals – contain this element in combination, chiefly with hydrogen, oxygen and nitrogen. Fats, sugars, starches, cotton, paper and numerous other things obtained from plants and animals are compounds of carbon with hydrogen and oxygen. Petroleum (from which kerosene oil is obtained) is largely a mixture of compounds made up of carbon and hydrogen. Carbon also occurs in carbonate minerals, such as limestone, chalk and marble. (All of these have the formula $CaCO_3$)

Experiment. To show that starch, sugar, cotton, and wool all contain carbon.

Take a dry test-tube and place a pinch of starch on its bottom. Fit its mouth with a cork carrying a delivery tube bent at right angle. Clamp the test-tube to a stand with a slight slope towards its mouth (Fig. 1.1). Heat the starch gently. What change do you observe ? The starch is charred and converted into a black substance.

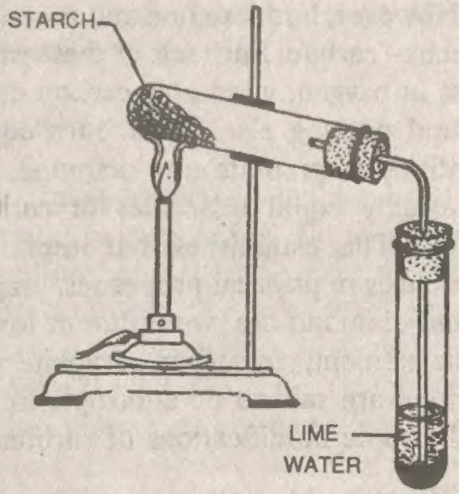


Fig. 1.1. To show that starch contains carbon.

Now dip the end of the delivery tube into lime water contained in a test-tube. Heat the black residue strongly. The residue glows and a gas is evolved that turns lime water milky. Why ?

Now repeat this experiment successively with sugar, cotton and wool. In each case, a black residue of carbon would be left behind which would form carbon dioxide upon strong heating in air.

You may prove the presence of carbon in any other substance of plant or animal origin much in the same way.

Carbon occurs in the atmosphere in carbon dioxide. Pure carbon is found in nature in two crystalline forms, *graphite* and *diamond.* Coal contains 65 to 90 per cent of free carbon.

1.2 Allotropic Forms of Carbon

Graphite and diamond differ from each other in physical properties, *e.g.,* colour, crystalline shape, hardness, lustre, etc. However, both are one and the same element – carbon. Each one of these when burns in oxygen, gives only carbon dioxide and nothing else. If we burn equal quantities of graphite and diamond, we get exactly equal quantities of carbon dioxide. This establishes that inspite of differences in physical properties, graphite and diamond are two different forms of one element, *viz.,* carbon. Graphite and diamond are said to be allotropic forms or allotropic modifications of carbon.

When an element can exist in more than one form in the same physical state, it is said to exhibit allotropy while these forms are called allotropic modifications of that element.

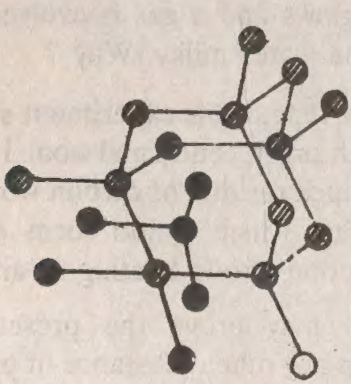


Fig. 1.3. Arrangement of carbon atoms in space in diamond.

The difference in the properties of graphite and diamond is due to the difference in their crystalline forms. The arrangement of carbon atoms in these two forms is shown in Fig. 1.2 and Fig. 1.3 respectively.

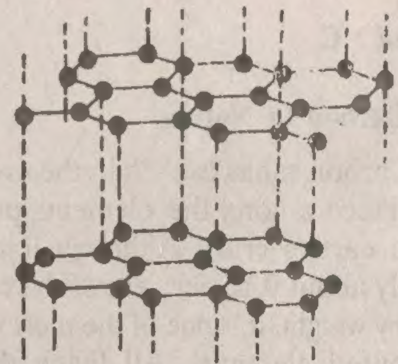


Fig. 1.2. Arrangement of carbon atoms in space in graphite.

1.3 Graphite

The word graphite is derived from the Greek word 'grapho', meaning to write. This is because graphite marks paper black and was used for marking the 'lead' of the writing pencils.

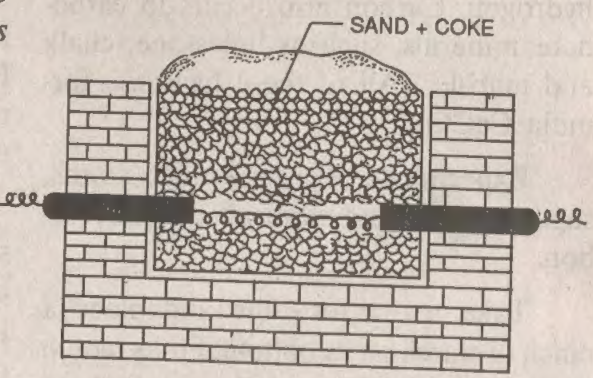


Fig. 1.4. Manufacture of graphite by heating coke and sand in an electric furnace.

Graphite occurs in nature in Siberia, Ceylon, U.S.A., Canda and

Czechoslovakia. Artificial graphite is made in large quantities by the Acheson's Process. This consists of heating anthracite coal (or coke) with a small quantity of sand to a very high temperature in an electric furnace. the furnace is fitted with two electrodes joined by a central cone of loose pieces of carbon.

Properties. (1) Graphite is a soft dark grey substance having a soapy touch. It has a metallic lustre.

(2) It crystallizes in hexagonal plates. (Fig. 1.5).

(3) Its specific gravity is 2.5.

(4) It is resistant to the action of heat and melts above 3,700°C.

(5) It is a good conductor of heat and electricity.

(6) When heated in oxygen (or air), graphite burns to form carbon dioxide only.

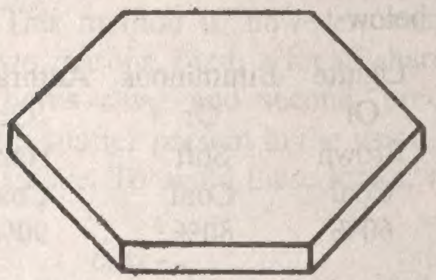


Fig. 1.5. Graphite crystal.

Uses. Since graphite melts only at a very high temperature, it is used for making crucibles for melting metals.

Being a good conductor of electricity, it is used for making electrodes, especially of electric furnaces.

It is used as a lubricant for machine parts subjected to high temperatures at which ordinary lubricants would be charred. For this purpose, it is used either as such or mixed with petroleum jelly.

It marks paper black and is, therefore, used for making pencils. The 'lead' of pencils is made by mixing powdered graphite with varying amounts of clay and pressing the mixture into thin sticks. The hardness of the 'lead' increases with the proportion of the clay added.

1.4. Diamond

Diamonds have been used as gems since times immemorial. These are highly expensive because of their limited availability in nature. At one time India was famous for diamonds. The famous *Koh-i-Noor* was mined in India. Other famous Indian diamonds are the *Pitt, Moghul, Darya-i-Noor, Nizam,* etc. Diamonds are weighed in carats (1 carat = 200 mg). The present Indian production of diamonds is insignificant and limited to the mines at Panna (M.P.) and Golkunda (Karnataka). Over 90 per cent of the world's diamonds are now obtained from South Africa.

Properties. (1) Diamond is the hardest substance known. It is the densest variety of carbon with a specific gravity of 3.5.

(2) It is transparent to light and possesses high refractive index (=2.45). This is why a diamond sparkles brightly, when suitably cut and polished (Fig. 1.6).

In their natural forms diamonds do not have lustre and look like ordinary pebbles.

Fig. 1.6. Cut and polished diamond.

(3) The natural diamonds form octahedral crystals (Fig. 1.7).

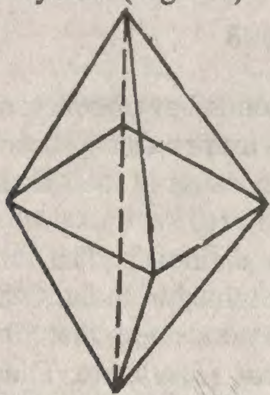


Fig. 1.7. Diamond crystal.

(4) Diamonds are bad conductors of heat and electricity.

(5) When heated to redness in oxygen, diamond burns giving only carbon dioxide. This proves that it is a form of carbon. When diamond is heated strongly out of contact with air, it is converted into graphite.

Uses. Diamonds are highly valued as gemstones. Bluish-white diamonds are the most precious of all. Black diamonds are not used as gems.

Owing to their extreme hardness, black and discoloured diamonds are used for glass cutting and as the teeth of rock-cutting saws, borers and drillers. Diamond dies are used for drawing thin wires of very hard metals, *e.g.*, tungsten.

1.5. Amorphous Carbon

This includes coal, coke, lampblack or soot, charcoal (wood and animal), etc. These do not consist of pure carbon. The best type of coal contains about 90 per cent of free carbon together with compounds of oxygen, hydrogen and nitrogen. Coal is formed by the decay of vegetation, chiefly forests, which existed millions of years ago. Owing to a limited supply of air, and together with pressure due to the weight of the superimposed strata, most of the volatile products were driven out and the carbon content increased.

Peat, lignite, bituminous coal and anthracite coal are the stages in the formation of coal from wood. The percentage of carbon in the different stages is as below :

Peat	Lignite	Bituminous	Anthracite
50%	Or	Or	Or
	Brown	Soft	Hard
	Coal	Coal	Coal
	60%	80%	90%

Coke is obtained from coal by heating coal in the absence of air (or in a limited supply of air), when all the volatile material contained in it is driven off. Coke is widely used as a domestic fuel and in the extraction of metals. Charcoal (wood and animal) is obtained by heating (wood or animal matter) in a limited

supply of air (or in the absence of air). Lampblack of soot is made by heating oils in a limited supply or air. Heating in the absence of air (or in a limited supply of air is known as *destructive distillation* or *dry distillation* of the substance.

The term amorphous means "non-crystalline", *i.e.,* having no definite form or shape. However, it has now been definitely established that the so-called amorphous varieties of carbon actually consist of extremely small crystals resembling those of graphite.

1.6. Wood Charcoal

Wood charcoal is formed when wood is heated strongly without a free access to air. In the old method, logs of wood are piled in a pit leaving a few spaces for air to enter (Fig. 1.8). The pile is covered with clay and fired. Part of the wood burns and heats the rest in a limited supply of air which is converted into charcoal.

This method is, however, wasteful for two reasons. First, a lot of charcoal, too burns away and second, precious volatile matter present in the wood goes into smoke. To avoid these losses, wood charcoal is now made by heating wood in big closed retorts out of contact with air.

Properties of Charcoal

(1) Charcoal is a black, brittle solid.

(2) It has a porous structure. The vascular vessels of the original wood are retained in the charcoal as so many pores. These pores contain air and this is why a piece of charcoal floats on water although its specific gravity varies from 1.8 to 2.1. However, if the same piece is heated strongly to drive out the enclosed air and then dropped in water, it sinks.

(3) It absorbs gases as well as colouring matter from solution. In this process the molecules of the substance absorbed cling to the surface of charcoal.

1.7. Animal Charcoal

When bones are subjected to destructive distillation in iron retorts, animal charcoal can be obtained. It is highly porous and a good absorbent also.

1.8. Coke

It is produced by destructive distillation of coal. By heating, coal loses gases

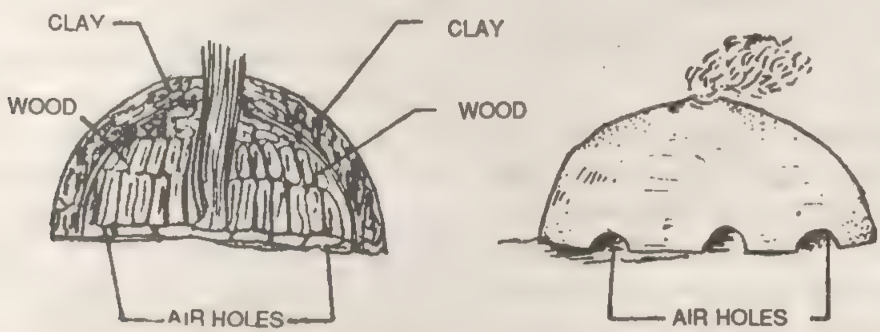


Fig. 1.8. Manufacture of wood charcoal (old method).

and other substances present, leaving behind a black residue which is called *Coke.*

1.9. Lamp Black

It is formed when kerosene oil, turpentine oil etc. are burnt in limited supply of air. Soot is a coarse form of lamp black present in smoke coming out of chimneys.

1.10. Hydrocarbons, Petroleum and Fuels

Carbon forms a very large number of compounds with hydrogen. The compounds of carbon and hydrogen are collectively called *hydrocarbons.* The simplest of all hydrocarbons is methane which is gaseous compound under ordinary conditions. The composition of methane corresponds to the formula CH_4. Other hydrocarbons may be gaseous, liquid, or soild substances. All hydrocarbons are insoluble in water, but gaseous and solid hydrocarbons readily dissolve in liquid hydrocarbons.

1.11. Methane CH_4

This hydrocarbon is also called *marsh gas,* since. it is formed in marshy ponds by the decomposition of vegetable matter under water. The bubbles of this gas rise to the surface when the bottom is agitated with a stick and may be collected as shown in Fig. 1.9.

Methane is often found in coal mines where it is formed during the carbonization of wood into coal. It forms explosive mixtures with air which have caused many dangerous explosions in coal mines. Hence, it is necessary to provide proper ventilation in coal mines and to periodically test the inside air for the presence of methane.

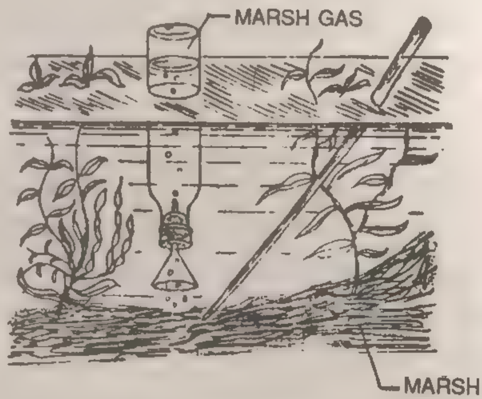


Fig. 1.9. Collection of marsh gas from a marshy pond.

Natural gas issuing from oil wells in petroleum fields contains 80 to 98 per cent of methane. In our country, natural gas is found in the oil fields of Assam and Gujarat.

Preparation of Methane. Mathane may be prepared in the laboratory by heating sodium acetate with soda lime. The latter is obtained by slaking quick lime with a solution of caustic soda.

$$\underset{\text{Sodium acetate}}{CH_3COONa} + \underset{\text{Sodium hydroxide}}{NaOH} \longrightarrow \underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Methane}}{CH_4}$$

Experiment. To prepare methane in the laboratory.

Mix about 2 g of anhydrous sodium acetate with 5 g of soda lime and place the mixture in a hard glass test tube. Fit the mouth of the test tube carrying delivery tube and clamp it to a stand as shown in Fig. 1.10. Dip the end of the delivery tube under water in a trough and place a beehive shelf over it.

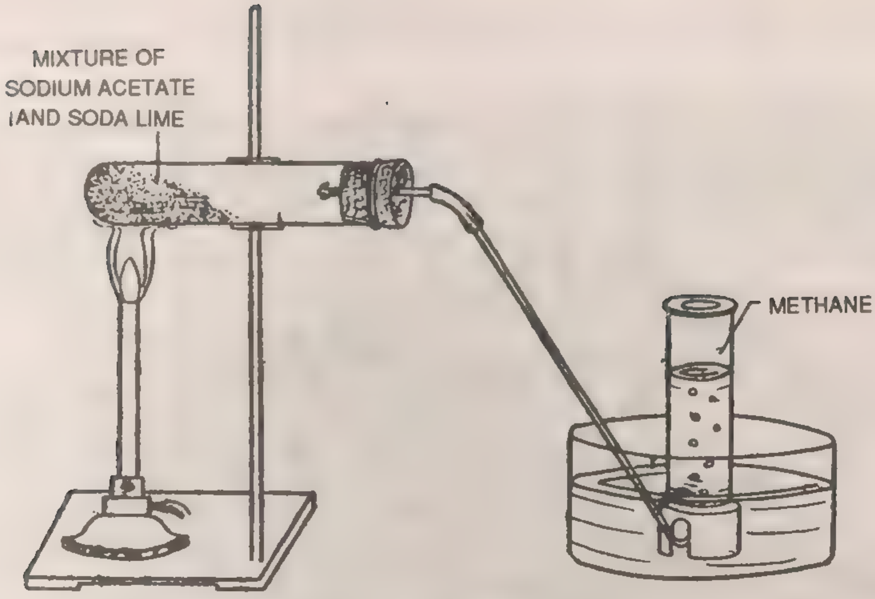


Fig. 1.10 Preparation of methane by heating sodium acetate with soda lime.

Heat the mixture, gently at first and then strongly. When bubbles start issuing from the delivery tube, place a water filled jar over the beehive shelf in an inverted position. Methane will collect in the jar by downward displacement of water.

Collect the gas in the required number of jars.

Properties of Methane. Methane is an odourless, colourless and tasteless gas. It is negligibly soluble in water and would therefore be easier to collect over water. It is much lighter than air. It burns in air with bluish flame producing carbon dioxide and water vapour.

$$\underset{\text{Methane}}{CH_4} + \underset{\text{Oxygen}}{2O_2} \longrightarrow \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2} + \underset{\text{Water}}{2H_2O}$$

Much heat is liberated in this reaction or we can say it is an *exothermic reaction.* Its mixtures with air or oxygen explode when ignited.

Uses of Methane

Methane, in the form of natural gas, is used as a domestic and industrial fuel. It is also used as a starting material for the preparation of a number of substances such as chloroform, methyl alcohol, etc.

1.12. Petroleum

Petroleum occurs in underground deposits as a dark, evil-smelling thick liquid usually floating over water. It is believed to have been formed by the decomposition of animal and plant remains under high pressure inside the earth. It is brought to the surface by drilling holes in the earth's crust and sinking pipes down to the oil-bearing rocks. The biggest oil-producing country in the world is the United States of America, which produces more than 15 per cent of the world production. Others in the order of production are : Russia,

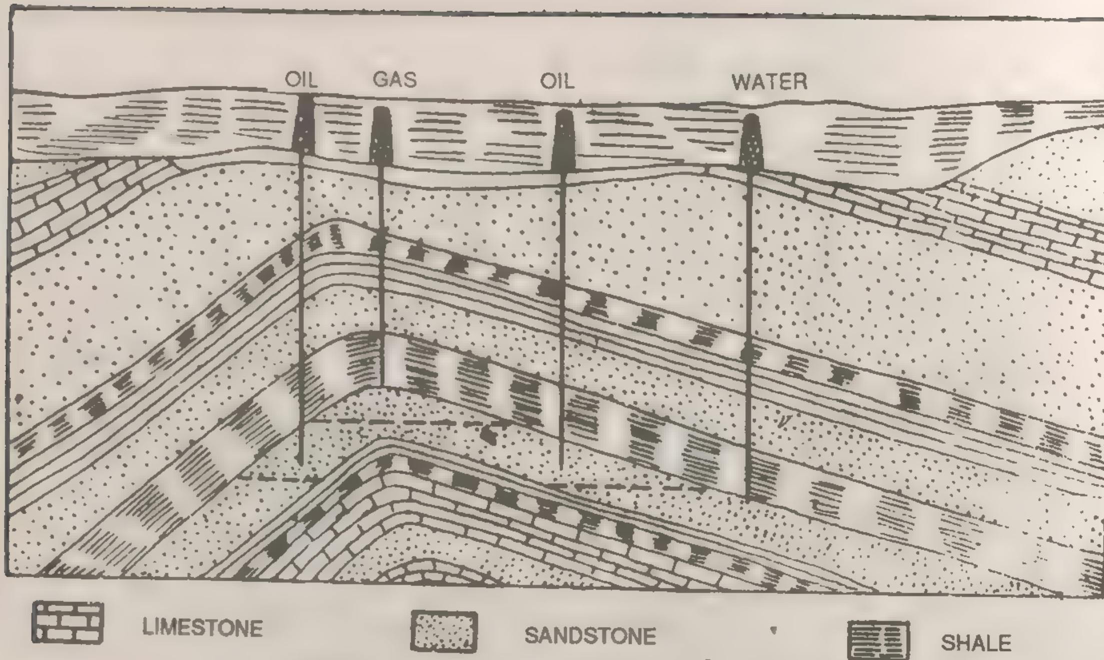


Fig. 1.11. Occurrence of petroleum inside the earth.

Rumania, Venezuela, Iran, Iraq and Borneo.

Petroleum is mainly a mixture of liquid hydrocarbons coupled with smaller amount of gaseous and solid hydrocarbons. As such, it does not have a constant boiling point.

Refining of Petroleum. Petroleum is separated into several useful materials by a special process of distillation, called *refining.* Distillation, as you know, consists in vaporizing a substance and then condensing the vapour (Fig. 1.12).

Crude petroleum is heated to 400°C and the resulting vapours are passed up a tall column. Here, they condense at different heights into various fractions. Each one of these fractions is a mixture of several hydrocarbons. The uncondensed gases pass out at the top of the column.

The main fractions of petroleum refining along with their uses are given in the table on the next page.

The last four fractions are obtained by distilling the residue from the evaporator in the absence of air. A study of the uses of the various fractions of petroleum shows how important the mineral is. Hence, it has been called *black gold.*

Petroleum Resources of India

The oil resources of our country are very meagre. Our important oil fields are located in Assam and Gujarat. Kangra valley in Himachal Pradesh and Combay in Maharashtra State are also prospective areas for the occurrence of oil. Under the aegis of the Oil and Natural Gas Commission of India, vigorous search for new oil fields is being made in all prospective localities in the country. It is

Table 1.1

Fractions	*Uses*	*Boiling Point Range (°C)*
1. Gas	As fuel. For making petrol by suitable process.	4 - 40
2. Petrol or gasolene (Naphtha)	As motor fuel. In dry cleaning.	40 - 200
3. Kerosene	As fuel for jet engines. As fuel in paraffin oil stoves. As in illuminant.	200 - 275
4. Gas oil	As fuel in diesel engines.	275 - 350
5. Lubricating oil	For lubrication.	350 - 400
6. Paraffin wax	For making candles and boot polishes	
7. Vaseline	In the preparation of toilet goods, ointments, etc.	
8. Asphalts	For tarring roads. In paints and varnishes. As rubber substitutes.	Above 400

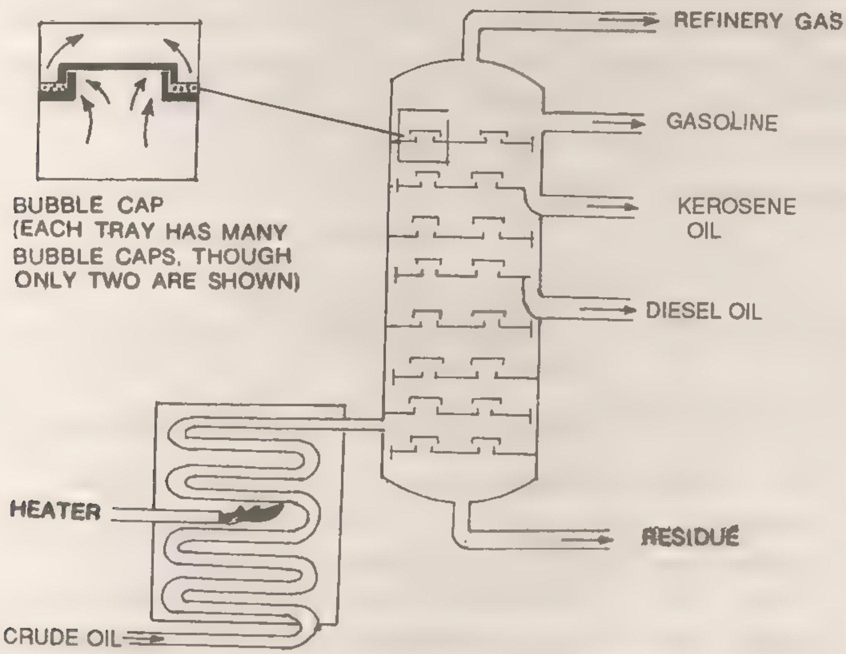


Fig. 1.12. Fractional Distillation of Petroleum.

hoped that the search yielding results, is not too distant a future.

1.13. Fuels

A fuel is a substance which may be burnt to produce considerable amount of heat energy. However, all combustible substances cannot be used as fuels.

Characteristics of a good fuel

(1) It should be cheap and readily available in large quantities.

(2) It should have a high energetic content. That is, it should produce much heat on burning.

(3) It should leave little ash on burning.

(4) It should not give out undesirable contents on burning.

All the fuels in use are carbon or carbon and hydrogen containing substances. When burnt, they release heat in two reactions : (i) burning of carbon in air to form carbon dioxide, and (ii) burning of hydrogen to form steam.

Fuels can be divided into *three classes :*

Solid fuels, *e.g.*, wood, coal, coke and charcoal. Wood consists mainly of cellulose ($C_5H_{10}O_5$). Its heat content is low and it is used as a fuel in homes. Charcoal too, is mainly a domestic fuel. Coal and coke are industrial fuels.

Liquid fuels, *e.g.*, petrol, diesel oil and kerosene. These are obtained from petroleum and used in internal combustion engines and jet engines. The heat content of liquid fuels is much higher than that of coal.

Gaseous fuels are coal gas, water gas, natural gas etc. Coal gas is produced by the dry distillation of coal. Water gas is a mixture of two combustible gases, carbon monoxide and hydrogen. It is made by passing steam through red hot coke ($H_2O + C \rightarrow H_2 + CO$). Natural gas occurs associated with petroleum. It consists largely of methane. Its heat content is higher than that of any other gaseous fuel.

Gaseous fuels possess many advantages over solid or liquid fuels. They can be easily transported through pipes, can be lighted or extinguished in a moment, leave no ash, produce no smoke, and give

Table 1.2 Some Fuels

Solid Fuels	*Liquid Fuels*	*Gaseous Fuels*
Coal	Kerosene oil	Natural gas (LPG)
Coke	Petrol	Petrol gas
Wood	Diesel	Water gas ($CO + H_2$)
Charcoal	Alcohol	Producer gas ($N_2 + H_2$)
Wax (Paraffin)	Liquefied Hydrogen	Acetylene

out much heat. Hence, their use in homes and industries is continually increasing.

1.14. Combustion and Flame

You have seen that when hydrogen, carbon (coal, charcoal etc.), magnesium, spirit, kerosene oil, etc. are enlighted, they burn in air with the evolution of heat and light. The heat liberated is sufficient to keep the process of continuous burning till the material has completely burnt away. Burning involves chemical change; hydrogen is converted into water, carbon to carbon dioxide, magnesium to magnesium oxide, etc. In all these cases, the substance burning is oxidized. That is, burning involves oxidation of the substance in question. The oxidation reaction between two substances, of which at least one is gaseous, with the liberation of heat and light is referred to as combustion. Substances those can burn are said to be *combustible ;* while cannot burn substances are *non-combustible.*

If the burning substance is a compound, the oxides of its constituent elements are produced. Thus, methane, a compound of carbon and hydrogen elements, burns in air (or oxygen) and forms oxides of both carbon and hydrogen into carbon dioxide and water (vapour) respectively.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

In case, air is not available in plenty carbon monoxide may be produced in place of carbon dioxide and this would be dangerous in view of the poisonous nature of the former. Hence, fuels, which invariably contain large quantities of free carbon or carbon compounds, must be burnt in a free supply of air.

Solid fuels, *e.g.*, wood, coal, coke, etc., leave behind ash after burning. The ash consists of the non-combustible impurities present in the fuel. The ash of wood, coal, etc., is rich in alkaline substances and plant nutrients, can be used along with chemical fertilizers. Purified liquid and gaseous fuels do not contain mineral impurities. Hence, such fuels do not leave any ash.

1.15. Spontaneous Combustion

Very often heaps of coal dust, hay, or oily rags catch fire all by themselves. The reason is centered in air, these substances undergo slow oxidation with evolution of heat. Since these substances are bad conductors of heat, the liberated heat is retained and accumulated. At a certain stage, the substances become optimum hot due to the accumulative effect of heat and ultimately begin to burn. Many hazardous fires have resulted, owing to the spontaneous burning of oily rags, in garages.

The combustion resulting from a process of slow oxidation is termed **spontaneous combustion.**

1.16. Flame

You are familiar with the flames of spirit lamp (in which spirit is burnt), bunsen burner (in which a gas burns), hydrogen, carbon monoxide, etc. Do all combustible substances burn with a flame ? No, not necessarily. Red-hot pieces of charcoal continue to burn but no flame is observed. A piece of

magnesium ribbon burns with a dazzling light showering brilliant sparks but certainly no flame is produced.

Experiment. To study the burning of some combustible substances.

(1) Hold a piece of magnesium ribbon by means of a pair of tongs. Put its open end in a flame until it starts burning. Now take it out and observe as the burning proceeds. Is there any flame ?

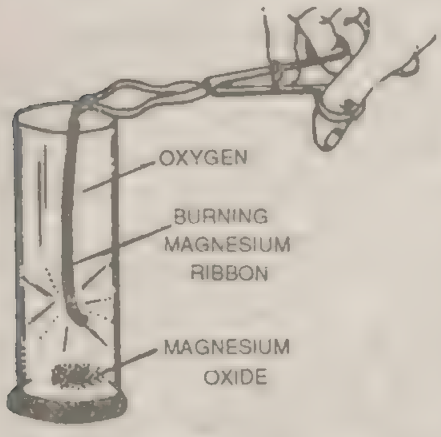


Fig. 1.13. Burning of magnesium in oxygen.

(2) Place a small piece of camphor on dish and light it. What happens ? Does the camphor burn with flame ?

(3) Take out a few drops of spirit on a broken porcelain and apply light. Observe what happens.

(4) Hold a wooden splinter in a flame until it is lighted. Note that it burns with a flame.

Obviously, some substances burn with flame, some without it. All combustible gases burn with flame – hydrogen, methane, carbon monoxide and all others. Among liquids, only those burn which are volatile and readily vapourise. These liquids, *e.g.*, spirit, methyl alcohol, etc. (or their vapour) burn with flame. Among solids, only those burn with flame which either contain volatile material, *e.g.*, wood or which are converted into vapour by the heat liberated in burning, *e.g.*, camphor. To summarize, a flame is produced only by the combustion of a gas or vapours. We may, therfore, define flame in the following words :

A flame is a zone of combustion of gases (or vapours)

1.17. Structure of the Flame

A flame is always hollow. This is because the gas in the middle does not come into contact with air. In other words, there are unburnt gases in the inner part of a flame.

Experiment. To show the presence of unburnt gases in a candle flame. Light a candle. Place the head of a match stick on the side of the flame and withdraw when it catches fire. Next, introduce the head of a match stick in the middle of the flame (Fig. 1.14). Why does it take longer to catch fire in this position ?

Fig. 1.14. Matchstick takes longer to burn in the middle of the candle flame.

Introduce a bent jet tube into the middle of the candle flame as shown in Fig. 1.15. Bring a lighted matchstick near the jet. A small flame appears. This is the unburnt gas of the candle flame burning in air.

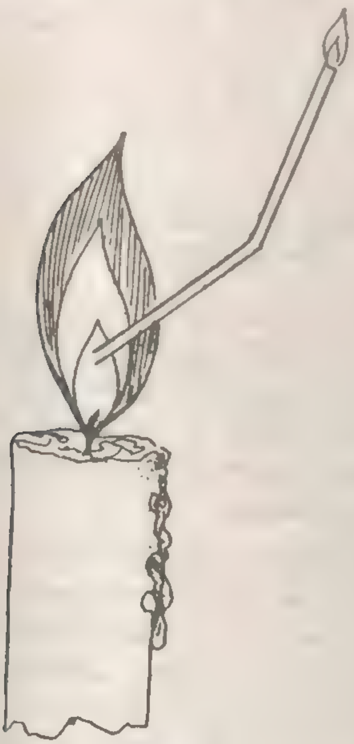


Fig. 1.15. The unburnt gas in a candle flame may be burnt in this manner.

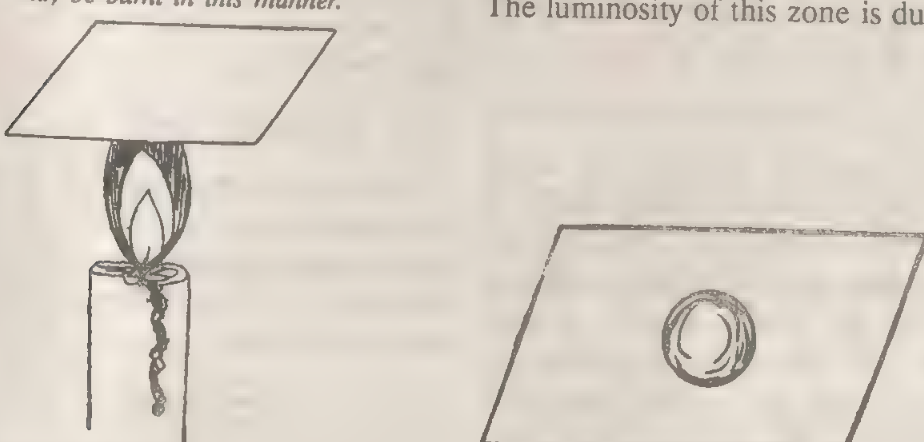
Now bring a piece of stiff paper horizontally over the candle flame and lower it rapidly until it almost touches the wick. Remove it just before burning would occur. Note the appearance of the paper. It would appear as in Fig. 1.16. Why has charring occurred in a ring ? Why is there a circle of almost unsigned paper inside the ring ?

All these observations indicate that the middle portion of the flame round the wick contain unburnt gas and is not sufficiently hot. This portion of the flame is called *zone of no combustion* and appears as dark zone in the candle flame.

1.18. Zones of the Candle Flame

The flame of a candle is, in fact, made up of four zones. These are shown in Fig. 1.17.

The *zone of no combustion* is surrounded by the *zone of partial combustion.* This zone (partial combustion) is luminous and its temperature is higher than that of the zone of no combustion. The luminosity of this zone is due to the



(a) (b)

Fig. 1.16. A paper held horizontally near the middle of candle flame is charred in a ring.

presence of the unburnt particles of carbon formed by the decomposition of wax vapour. These particles become red hot and glow brilliantly. The presence of the particles can be shown by holding a chalk stick across this zone for some time (Fig. 1.18). Unburnt particles of carbon will deposit on the chalk stick in the form of soot. It is obvious that the combustion in this zone is not complete but only partial.

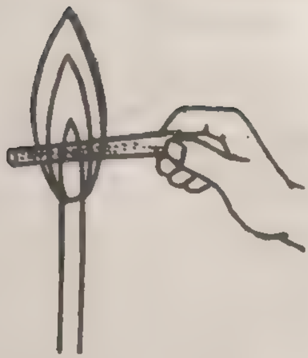


Fig. 1.18. Zone of partial combustion contains unburnt particles of carbon.

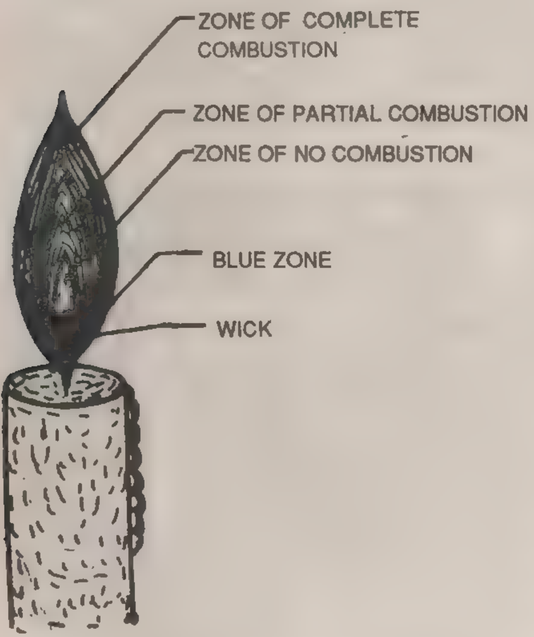


Fig. 1.17. Zones in the candle flame.

The outermost zone of the flame surrounding the zone of partial combustion is called the *Zone of complete combustion.* Here the combustible gaseous substances get plenty of air so that complete combustion can occur. This zone is non-luminous and visible only with difficulty. It is the hottest part of the flame.

At the base of the flame is a small *blue zone* which is non-luminous. This is formed by the combustion of carbon monoxide which is produced by the reduction reaction of carbon dioxide with carbon particles.

How does a candle burn ? A candle is made of wax which consists of hydrocarbons. When a candle is lighted, the wax on the wick melts and some of it vapourises. The wax vapour takes fire and melts more wax. the molten wax is drawn up the wick to the flame where it boils to give more wax vapour and the candle continues to burn.

1.19. Oxides of Carbon

Carbon burns in air (or oxygen) to form carbon dioxide (CO_2) in a free supply of air and carbon monoxide (CO), when the air is insufficient for its complete combustion.

$$C + O_2 \rightarrow CO_2 \text{ (Carbon dioxide)}$$

$$2C + O_2 \rightarrow 2CO \text{ (Carbon monoxide)}$$

Carbon monoxide is, thus, the product of incomplete combustion of carbon. It burns in air (or oxygen) to produce carbon dioxide which is the product of complete combustion of carbon.

$$2CO + O_2 \rightarrow 2CO_2$$

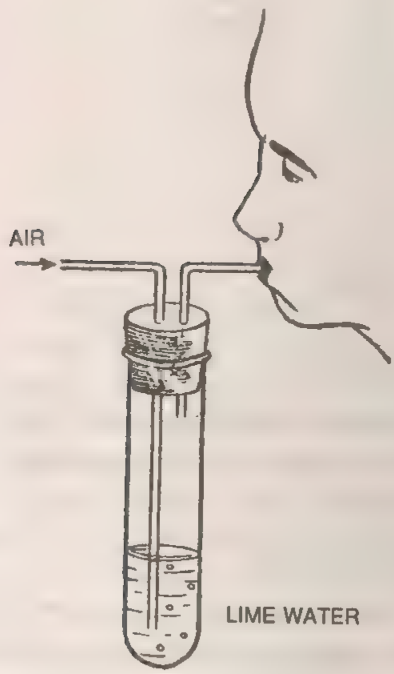


Fig. 1.19. Exhaled breath.

Carbon dioxide is present in air to the extent of about 0.03 per cent by volume. It is also present in exhaled breath. If you breathe out into lime water taken in a test tube. It will turn milky due to the action of carbon dioxide (Fig. 1.19). All natural water contain small quantities of dissolved carbon dioxide. Large quantities of carbon dioxide are evolved during volcanic eruptions and burning of fuels like coal.

CARBON DIOXIDE

1.20. Laboratory Preparation

Carbon dioxide is produced when carbon or a compound of carbon is burnt in excess of air. However, this method is not convenient in practice. Carbonates, such as magnesium carbonate or calcium carbonate (chalk, marble, etc.) give off carbon dioxide upon strong heating leaving behind carbon dioxide.

$$C + O_2 \rightarrow CO_2$$

$$\underset{\text{Magnesium carbonate}}{MgCO_3} \longrightarrow \underset{\text{Magnesium oxide}}{MgO} + \underset{\text{Carbon dioxide}}{CO_2}$$

$$\underset{\text{Calcium carbonate}}{CaCO_3} \longrightarrow \underset{\text{Calcium oxide}}{CaO} + \underset{\text{Carbon dioxide}}{CO_2}$$

This reaction, too, is not convenient enough for the preparation of carbon dioxide in the laboratory.

In the laboratory carbon dioxide is prepared by the action of dilute hydrochloric acid on lumps of marble which is in the form of pure calcium carbonate. In this reaction, carbon dioxide is liberated in a slow stream. In the reactions of acids with chalk/sodium carbonate or sodium bicarbonate ; carbon dioxide is liberated very fast, since these substances are in the form of fine particles.

Experiment. To prepare carbon dioxide by the action of dilute hydrochloric acid on marble.

Place a few marble chips in a bottle having a wide mouth. Stopper the bottle

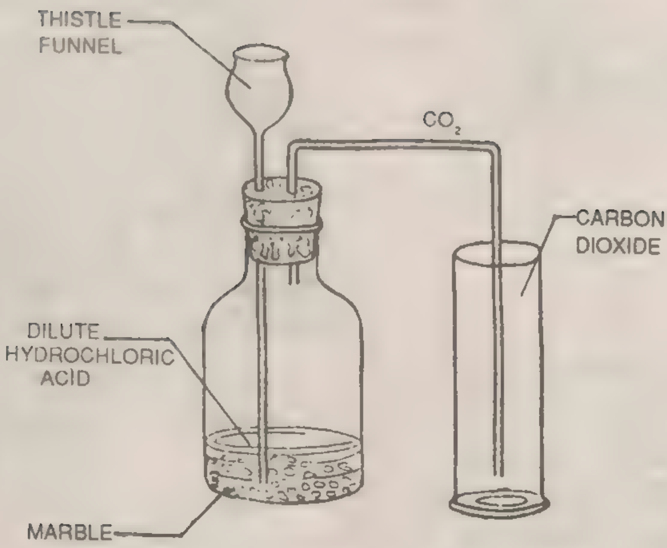


Fig. 1.20. Preparation of carbon dioxide in laboratory.

with a double bore cork carrying a thistle funnel and a delivery tube twice bent at right angles. Pour water down the thistle funnel until its lower end dips under water. Now pour concentrated hydrochloric acid until the effervescence due to the evolution of carbon dioxide becomes very brisk. The gas coming out of the delivery tube for a while is the air displaced from the apparatus by the carbon dioxide. Allow it to escape.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Now introduce the delivery tube, into a gas jar. The gas will be collected in the jar by the upward displacement of air. To find out when the jar is full of the gas, bring a lighted splinter near its mouth. When carbon dioxide has reached upto its brim, the splinter will be extinguished. Now remove the jar and cover its mouth with a greased round glass plate and set aside. In this manner collect the gas in several gas jars.

Physical Properties

1. Carbon dioxide is a colourless gas with a faint odour and a faint acidic taste.

2. It is nearly one and a half times as heavy as air, one litre of it is weighed 1.96 g under normal conditions. This is why it can be poured out from one vessel into another like a liquid.

Counterpoise an empty beaker on a balance. Take a jar full of carbon dioxide and tilt it as if you are pouring out something into the beaker. Why does the pointer swing towards the pan with the weights ? Why has the beaker become heavier ? Carbon dioxide being heavier can be poured downward.

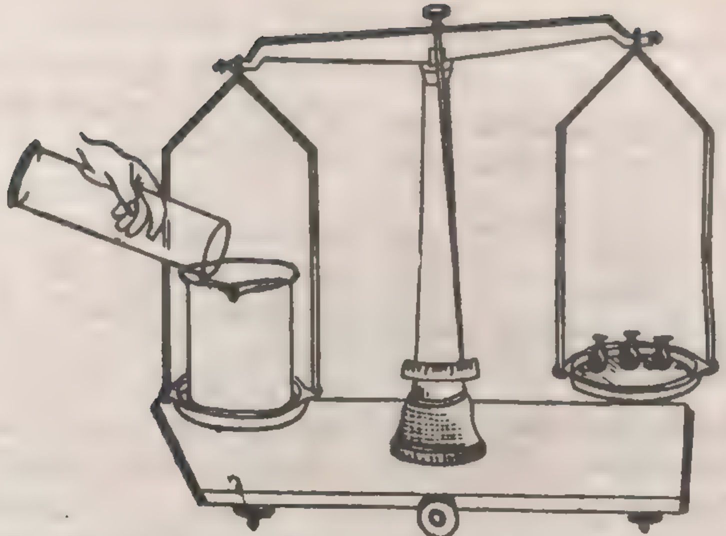


Fig. 1.21. To show that carbon dioxide is heavier than air.

3. It is fairly soluble in water. if you invert a jar full of carbon dioxide in a trough of water, the level of water will soon rise upward inside the jar as the gas dissolves in water. Its solubility increases as the pressure is increased. Soda water which is a solution of carbon dioxide in water, is prepared by dissolving the gas in water under high pressure. When the bottle is opened, the pressure is released and most of the dissolved gas escapes with a fizz.

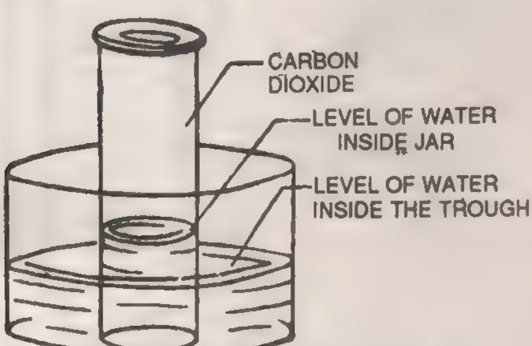


Fig. 1.22. Carbon dioxided is fairly soluble in water.

Chemical Properties

1. When a lighted candle is introduced in a jar of carbon dioxide, it is immediately extinguished and the gas does not burn. This shows that carbon dioxide is neither combustible nor a supporter of combustion.

2. However, a burning ribbon of magnesium continues to burn in carbon dioxide setting free its carbon and combining with its oxygen to form magnesium oxide.

$$\underset{\text{Carbon oxide}}{CO_2} + \underset{\text{Magnesium}}{2Mg} \longrightarrow \underset{\text{Carbon}}{C} + \underset{\text{Magnesium oxide}}{2MgO}$$

Experiment. Hold a piece of clean magnesium ribbon with a pair of tongs. Keep one end of it in a flame until it catches fire. Introduce the burning ribbon in a jar of carbon dioxide. What do you observe ? The ribbon continues to burn forming a white ash-like substance (it is magnesium oxide) and black specks

of carbon are deposited on the walls of the jar.

3. Carbon dioxide is an acidic oxide. It dissolves in water to form carbonic acid.

$$\underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2} \longrightarrow \underset{\text{Carbonic acid}}{H_2CO_3}$$

This acid is known only in solution and has not been isolated in a free state.

Carbon dioxide neutralizes alkalies to form two series of salts : the carbonates and bicarbonates.

$$2NaOH + Co_2 \longrightarrow \underset{\text{Sodium carbonate}}{Na_2CO_3} + H_2O$$

$$Na_2CO_3 + CO_2\, H_2O \longrightarrow \underset{\text{Sodium bicarbonate}}{2NaHCO_3}$$

4. When carbon dioxide is passed into lime water it turns milky due to the formation of insoluble calcium carbonate. The minute particles of this substance remain suspended in water imparting it a milky appearance.

$$\underset{\text{Calcium hydroxide (lime water)}}{Ca(OH)_2} + \underset{\text{Carbon dioxide}}{Co_2} \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3} + \underset{\text{Water}}{H_2O}$$

5. In the presence of sunlight, carbon dioxide reacts with water inside the organism of green plants to form sugars, strach and cellulose. It is with these substances that plants grow. Thus, the atmospheric carbon dioxide provides nourishment to the plants. Cultivated plants in a field of one acre utilise about 100-200 kg. of carbon dioxide everyday.

Uses

Carbon dioxide finds many uses in industry. Its more important uses are described below :

1. It is used in the manufacture of aerated waters which contain carbon dioxide dissolved under pressure in water along with sugar, some colouring, and essence.

2. Large quantities of carbon dioxide are used up in the manufacture of washing soda and baking soda.

3. Dry ice, produced by the rapid evaporation of liquid carbon dioxide, is used for preserving perishable foods.

4. Air containing about 15 per cent of carbon dioxide does not support combustion. Hence, carbon dioxide is used for extinguishing fires.

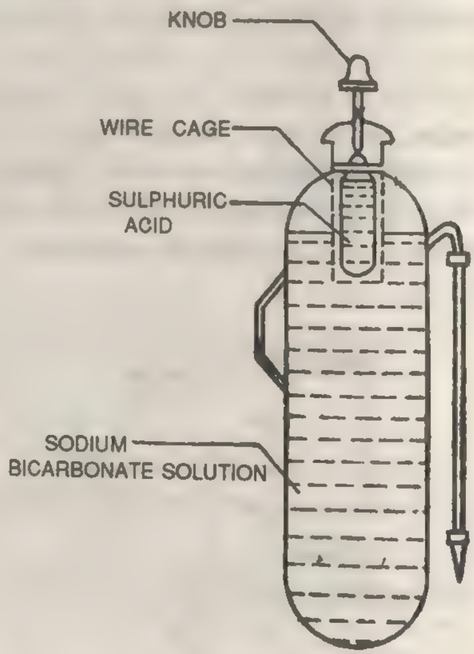


Fig. 1.23 (a) A chemical fire extinguisher

A household fire extinguisher usually consists of a steel cylinder contain-

ing a solution of sodium carbonate. A glass ampoule filled with sulphuric acid is fixed in a wire cage at the top part of the cylinder. This ampoule can be broken by striking a knob [Fig. 1.23(a)].

To operate the extinguisher, it is inverted and struck against a hard surface whereby the knob is pushed inward breaking the acid containing ampoule. The acid now comes in contact with the sodium bicarbonate solution. As a result of the reaction between these substances, carbon dioxide is evolved.

$$\underset{\text{Sodium bicarbonate}}{2NaHCO_3} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4} + \underset{\text{Water}}{2H_2O} + \underset{\text{Carbon dioxide}}{2CO_2}$$

The carbon dioxide thus liberated forces out a stream of the liquid which is directed on to the fire. The air supply of the fire is thus cut off whereby it is extinguished [Fig. 1.23 (b)].

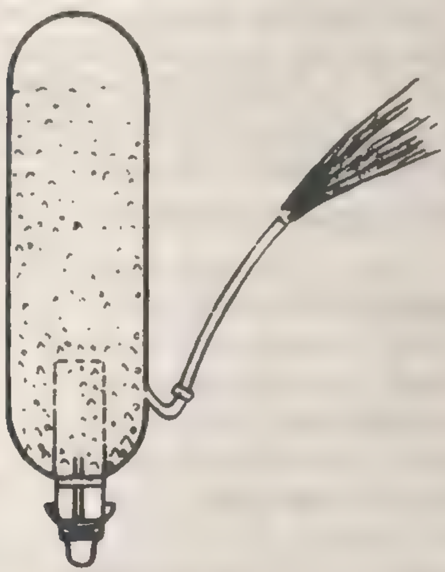


Fig. 1.23 (b). The fire extinguisher in operation.

1.21. Bicarbonates

Bicarbonates of sodium and potassium are known to exist in the solid state ; those of other metals are formed only in solution. All bicarbonates are soluble in water. On treatment with strong acids, they liberate carbon dioxide. This, sodium bicarbonate reacts with hydrochloric acid according to the following equation :

$$\underset{\text{Sodium bicarbonate}}{NaHCO_3} + \underset{\text{Hydrochloric acid}}{HCl} \longrightarrow \underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2}$$

Uses

Sodium bicarbonate ($NaHCO_3$) salt is usually called baking soda. It is used in baking powders as leavening agent in cooking and in medicine to neutralize the acidity in the stomach.

1.22. Carbonates

Carbonates of all metals, except those of sodium and potassium, are not soluble in water. Insoluble carbonates of many metals occur in nature. Calcium carbonate ($CaCO_3$) occurs in nature as limestone, chalk, and marble. In India, extensive deposits of limestone are found in Rajasthan. It is used as a building material and for the production of lime, which it gives upon strong heating.

$$\underset{\substack{\text{Calcium carbonate}\\\text{(Lime stone)}}}{CaCO_3} \longrightarrow \underset{\substack{\text{Calcium oxide}\\\text{(lime)}}}{CaO} + \underset{\text{Carbon dioxide}}{CO_2}$$

Marble is less abundant therefore, more costly than limestone. It is a

lustrous white stone although coloured varieties are also found. The colours in marble are produced by the traces of impurities present. It is also used as a building material. In India, marble is found in Rajasthan and Madhya Pradesh.

Magnesium, copper, zinc, lead, iron, etc., also occur in nature as carbonate minerals.

Properties of Carbonates

1. Only sodium carbonate and potassium carbonate are soluble in water ; carbonates of all other metals are insoluble. Insoluble carbonates, however, dissolve in water containing dissolved carbon dioxide. The dissolution occurs due to the formation of bi-carbonates which are soluble (see action of CO_2 on lime water).

$$\underset{\substack{\text{Calcium carbonate}\\\text{(insoluble)}}}{CaCO_3} + \underset{\text{Water}}{H_2O} + \underset{\substack{\text{Carbon dioxide}\\\text{(dissolve)}}}{CO_2} \rightarrow \underset{\substack{\text{Calcium bicarbonate}\\\text{(soluble)}}}{Ca(HCO_3)_2}$$

2. Carbonates of sodium and potassium are stable to heat ; those of other metals decompose on strong heating to give oxides and carbon dioxide.

Thus,

$$\underset{\substack{\text{Magnesium}\\\text{carbonate}}}{MgCO_3} \xrightarrow{\text{Heat}} \underset{\substack{\text{Magnesium}\\\text{oxide}}}{MgO} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2}$$

3. All carbonates readily react with acids with the liberation of carbon dioxide.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$$

The liberation of carbon dioxide in such reactions occurs with brisk effervescence. As such, the reaction with an acid provides a handy method for knowing whether a given mineral is a carbonate or not. The mineral is treated with a few drops of dilute hydrochloric acid. If a brisk effervescence is observed, it is a carbonate otherwise not.

Experiment. Place a few grains of marble, limestone, chalk, clay and coal on separate watch glasses. Pour a few drops of dilute hydrochloric acid on each sample. In which samples do you observe an effervescence ? Why does it not occur with clay and coal ? These minerals are not carbonates.

1.23. Sodium Carbonate

This compound is popularly called *washing soda.* It is a white substance which forms very fine crystals. The crystals effervescence in air and crumble to a powder. It is used in the manufacture of glass, soap powders, caustic soda, and a number of useful sodium salts.

1.24. Carbon Monoxide

The pinkish-blue flames which are often seen on the top of a vigourous coal fire are carbon monoxide flames. How is carbon monoxide formed in a coal fire ? To understand this, see Fig. 1.24. The lower layers of coal receive plenty of air and here, the carbon burns to form carbon dioxide.

$$C + O_2 \rightarrow CO_2$$

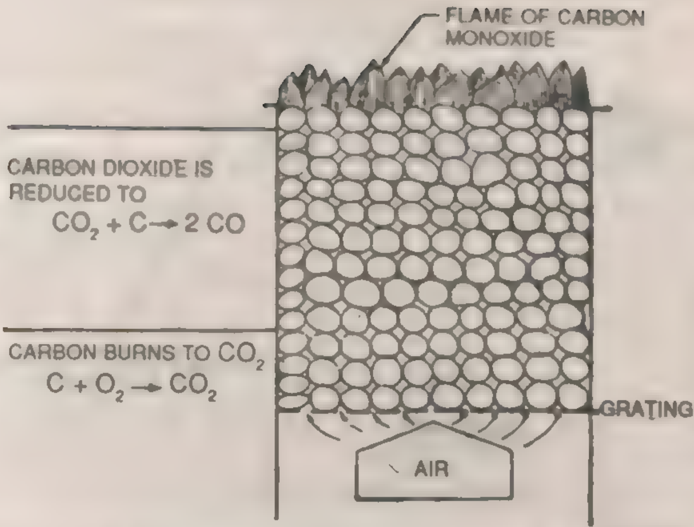


Fig. 1.24. Formation of carbon monoxide and carbon dioxide in a deep and coal fire.

The carbon dioxide formed which rises through the upper layers of red hot carbon is reduced to carbon monoxide.

$$CO_2 + C \rightarrow 2CO$$

The carbon monoxide burns at the top where air is plentiful to form carbon dioxide.

$$2CO + O_2 \rightarrow 2CO_2$$

Carbon monoxide may be prepared in the laboratory also by passing carbon dioxide through red-hot charcoal.

Experiment. To prepare carbon monoxide.

Take a hard glass tube of about 5-6 cm. diameter. Place heap of charcoal inside the tube and clamp it in a horizontal position. Heat the charcoal unit, it glows brilliantly. Now generate carbon dioxide in a bottle as described earlier and connect its delivery tube to one end of the wide tube containing glowing charcoal. Fix up a delivery tube at the other end of the wide tube and make arrangement for the collection of a gas by the downward displacement of water (Fig. 1.25). Collect the gas issuing from the wide tube in a few gas jars.Then, first disconnect the carbon dioxide generator and then dismantle the whole appartus.

The gas collected in the jars is carbon monoxide formed by the reduction of carbon dioxide as it passed through glowing charcoal.

Physical Properties

1. Carbon monoxide is a colourless, tasteless and almost odourless gas.

2. It is only very sparingly soluble in water.

3. It is only very slightly lighter than air (the density of air = 14.4 and that of carbon monoxide = 14).

4. It is extremely poisonous. It makes the haemoglobin of the blood incapable

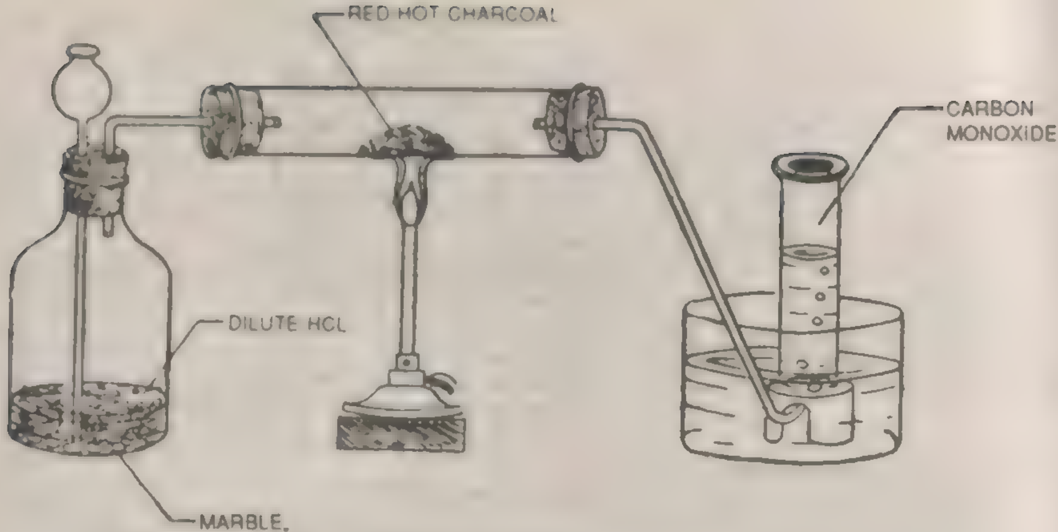


Fig. 1.25. Preparation of carbon monoxide

of carrying oxygen. One volume of carbon monoxide in 800 volumes of air is enough to cause death in about half an hour. Breathing a small quantity of this gas causes dizziness, nausea, and finally unconsciousness. Being odourless, the victim of carbon monoxide poisoning is not able to feel the presence of the killer. Hence this gas is a treacherous poison. Since it is formed when carbon burns in insufficient quantity of air, you can realize how dangerous it is to keep coal-fire burning inside a closed room. Poisoning by the exhaust fume of an automoblie in a closed garrage is also due to carbon monoxide present in large quantities in the fumes.

The victim of carbon monoxide poisoning should be immediately moved out in an open air. If the breathing is very slow, he should be given artificial respiration with carbogen which is a mixture of oxygen with 8 percent carbon dioxide. A doctor must be summoned at the earliest.

Uses. Carbon monoxide is a constituent of many a gaseous fuels, *e.g.*, producer gas, water gas etc. The gas is used as a reucing agent in metallurgy for extracting metals from their oxides. Carbon monoxide is also used for producing artificial petrol and in the manufacture of methyl alcohol.

SUMMARY

1. Carbon is very widely distributed element. It occurs in all plants and animals in combination with other elements.

2. Diamond, graphite, charcoal, coke, lamp-black are forms of carbon in nature.

3. Various forms of carbon have different physical properties and uses.

4. The componds of carbon and hydrogen are collectively called hydrocarbons.

5. Methane, CH_4, is the simplest hydrocarbon. It is formed by the decomposition of dead plants in the absence of air and also found in coal mines.

6. In the laboratory, methane is prepared by heating sodium acetate with soda lime.

7. Petroleum is formed by the decomposition of dead animals and plants due to geological changes.

8. Crude petroleum is separated into industrially useful products *e.g.*, Petrol, Kerosene etc. by a process of fractional distillation.

9. A fuel is a substance which may be burnt to produce considerable heat without the formation of objectionable products.

10. Fuels are of three types : solids, liquids and gaseous.

11. Substances that can burn are called combustible substances, other are said to be non-combusi-tible.

12. Spontaneous combustion is the combustion that results from a process of slow oxidation.

13. A flame is a zone of combustion or gases or vapours.

14. A candle flame is made up of four zones

(a) Zone of incomplete combustion

(b) Zone of partial combustion

(c) Zone of complete combustion

(d) The blue zone.

15. When carbon burns in insufficient air, carbon monoxide is formed ; while in plentiful supply of air, carbon dioxide is produced.

16. Carbon dioxide is an acidic oxide. It dissolves in water to form carbonic acid. It is a dibasic acid gives rise two series of salts ; carbonates (normal salts) and bicarbonates (acid salts).

17. Carbon dioxide turns lime water milky owing to the formation of insoluble calcium carbonate.

18. Carbon dioxide is used for extinguishing fires and atmospheric carbon dioxide is used up by green plants in the presence of sunlight for making strach, sugars, etc.

19. Carbon monoxide is a reduction product of carbon dioxide and is found when the latter is passed through red-hot charcoal.

20. Carbon monoxide renders the haemoglobin of the blood incapable of carrying oxygen. That is why it is a poisonous gas.

QUESTIONS

1. Why are black substances produced when food materials, fuels and cotton are burnt ?

2. What do you understand by the term "allotropic modifications of an element ?"

3. Name three elements that exhibit allotropy.

4. Why is diamond such a hard substance ?

5. Why does graphite find use in electrical appliances ?

6. How is that inspite of being heavier than water, charcoal does not sink in it ?

7. What are hydrocarbons ? Name the simplest hydrocarbon. What are its important properties and uses ?

8. What is petroleum ? How is it separated into petrol, kerosene and other industrially useful products.

9. What is a fuel ? What are the characteristics of good fuel ?

10. Write a note on the "Petroleum resources of India".

11. While camphor burns with a flame, charcoal only smoulders. Explain the reason.

12. What is the necessity of a wick in the candle ?

13. Give an account of the physical and chemical properties of carbon dioxide. How would you show that

(a) Carbon dioxide is heavier than air,

(b) Carbon dioxide contains carbon,

(c) Carbon dioxide is an acidic oxide .

14. Describe a fire extinguisher.

15. Why is carbon monoxide a poison ? What treatment would you give to victim of carbon monoxide piosoning ?

16. Fill in the blanks

(i) .... and .... are soft, dark grey crystalline substances.

(ii) The branch of chemistry dealing with the study of carbon and its compound is .... chemistry.

(iii) When kerosene is burnt in a limited supply of air, ... is formed.

(iv) .... coal is used as domestic fuel.

(v) Compounds of carbon and hydrogen are called ....

(vi) Methane is also called .... gas.

(vii) Digestive salts generally contain ....

(viii) The hottest part of the flame is known as ....

(ix) Refining of petroleum is done by the process of ....

(x) A fire extinguisher is a device to .... combustion.

ACTIVITIES

1. Collect pieces of charcoal, graphite and coke. Make an electric circuit to test each sample for its conductivity.

2. Keep camphor, kerosene, petrol and spirit separately and burn them. Do they burn with a flame ?

3. Listing the various uses of diamond, graphite and charcoal etc.

4. To collect information regarding different sources of various fuels.

5. To locate the various petroleum producing areas in the map of India.

CHAPTER 2

ALTERNATIVE SOURCES OF ENERGY

1.1. Energy a Need

Over the past several years, a sort of crisis has been developing and deeping in regard of the demand, supply and utilization of energy not only in India but all over the world. Energy plays an important role in the development of an economy. Be it industrial or commercial or domestic use, its importance can hardly be over emphasized. You know that you can't enjoy your radio casette tape recorder, two-in-one, T.V., Video, Video game without electrical energy. Your mother is in a problem when electricity is not there and she is handicapped of using her mixy, hot case, toaster etc. When you go for a bath in winter and find that your geyser is not supplying hot water since electricity is not there, how much do you curse the government that it can't even provide us sufficient electricity according to our need.

Similarly all industries using electricity will not be able to keep their level of production if sufficient electricity is not made available to them. If we don't have sufficient stock of petroleum, how can we keep over transport running, continuous supply of cooking gas and other raw materials being used by different industries. A continuous supply of coal is needed to a thermal power station. A regular and sufficient rain fall is needed for our hydro-electric power station to work. So all sources of energy have to be mobilised.

2.2. Limited Stocks of Conventional Sources of Energy (Fossil fuels)

The stocks of fossil fuels as coal, petroleum, natural gas, natural gas liquids and tar sands are limited. How long can we depend upon them ? Coal was the first fossil fuel to be utilized by man. Different types of coals are used for different purposes in different industries. It is also used in thermal power stations to generate electricity, in brick kilns to dry and burn clay, in smithys to melt gold or reshape iron and in houses to cook food. Oil rose to prominence as an energy source during the first half of the twentieth century. Natural gas and gas liquids has a geological history of formation very similar to oil. There are sands impregnated with a heavy crude oil. Sand is mined, oil removed from the sand by washing in hot water and the sand is returned to the mine. Nearly ten tonnes of sand is processed to obtain one tonne of oil.

The stocks of Uranium and Thorium are also limited. These material produce tremendous amount of energy by chain

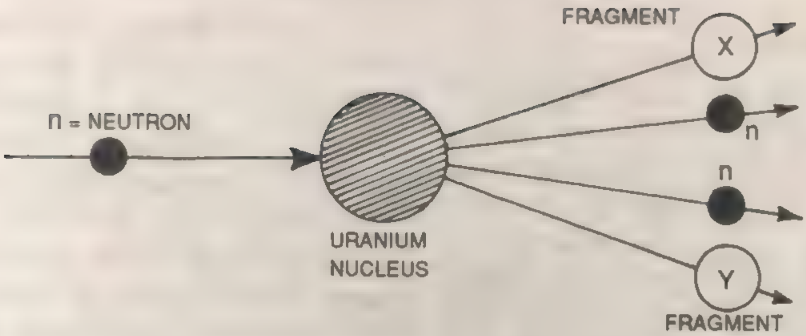


Fig. 2.1

reaction of nuclear fissions. The breaking of nucleus into nearly two equal fragments is called *fission.* The energy so obtained is called *nuclear energy.*

Since the stocks of fossil fuels, uranium and thorium are limited in our country, the need for development of alternate and renewable sources of energy was felt. In 1982 a separate Department known as Department of Non-Conventional Energy Sources was set up by the Government of India.

The sources of energy as the *fossil, fuels, uranium and thorium* called *stored sources* cause air pollution. Some coal has a high sulphur contents which increases the severity of the air pollution problem. There is a big environmental problem by

Fig. 2.2. Shows so many vehicles on a traffic signal producing large smokes making air polluted.

heavy traffics on account of smoke of petroleum waste in metropolitan cities like Delhi.

2.3. Hydro-energy

The falling water from a large height has tremendous amount of energy (potential). This energy in flowing water is known as *hydro-energy.* In a hydro-electric power station, the water falling from a height makes a turbine coupled with an electric generator to run. The generator thereby generates electricity. In India we have a large number of hydro-electric power stations. The biggest out of them is Bhakra Dam where water falls from a height of 1000 ft. and its capacity is 420 MW electric power.

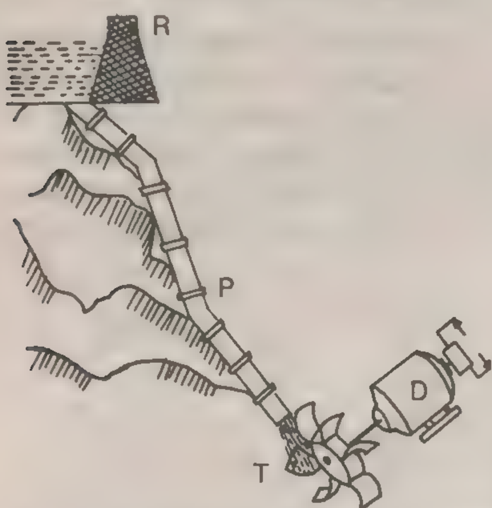


Fig. 2.3. The principle underlying the generation of hydro-electricity : R - reservoir ; P - penstock pipes ; D- dynamo ; T - water turbine.

2.4. Non-Conventional Sources of Energy

The non-conventional sources of energy which are known as continuous sources of energy include (1) Ocean energy (2) Geothermal energy (3) Solar energy (4) Wind energy and (5) Bio-gas energy etc.

(1) **Ocean Energy.** It includes ocean thermal gradient energy, wave energy and tidal energy. Thermal gradient and wave energies are available throughout the off-shore area. The tidal energy is caused by the combined effect of kinetic and gravitational potential of the earth-moon-sun system. By studying changes in the earth's period of rotation, the rate of dissipation of tidal energy may be determined.

A dam is built between a natural coastal basin and the open sea, allowing the flow of water into and out of the basin to be controlled. Flow would be allowed at a low and high tide. At a high and low tide gates of the dam would be opened and closed water would flow into or out of the basin, driving generators and producing electricity. But the ocean energies will take long time to harness on a large scale.

(2) **Geothermal Energy.** It is generated in the earth's interior, principally as a result of decay of radio active nuclei. This energy is not significant as a continuous sources of energy.

(3) **Solar Energy.** The energy obtained directly from sun is called *Solar energy.* It is available in a rather dispersed form and in India its average insolation rate is only 5 to 8 KWH per square metre of horizontal surface per day. For small scale uses where energy is required at low or medium temperatures, concentration and conversion costs are not required and hence solar energy may be

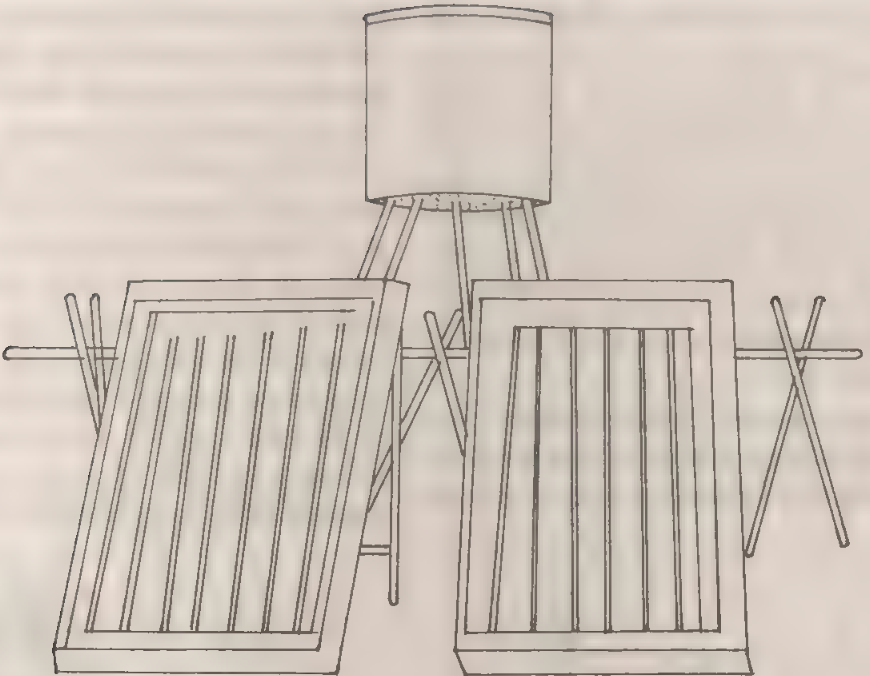


Fig. 2.4

more competitive. For requirement of hot water system in a hotel, drying or even cold storages, solar energy could be used without much concentration.

For temperatures upto about 100°C indigenously developed flat plate collectors can be used. A collector consists of blackened sheet of metal mounted on a sloping roof with equally spaced water pipes.

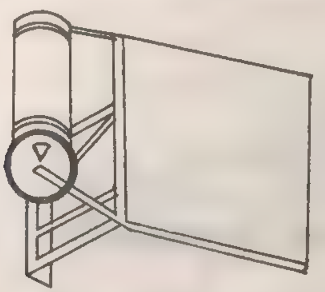


Fig. 2.5. Solar Geyser

Solar geysers are used for domestic and industrial water heating.

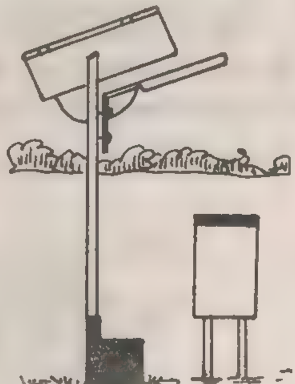


Fig. 2.6. PV Light

Solar Cells. (See Chapter of electricity Unit 9, page 144). Solar Photovoltaics are used for street lighting. A Photovaltaics Power house for electricity generation can be made using Solar

Photovaltaics. The power is stored in batteries and it can be used for village street lighting and other purposes.

Solar Distillation. The solar distillation of salt water has been reasonably successful. Solar distillation supplies very pure fresh water. The solar energy is concentrated in the black bottomed glass container in which salt water is kept and the evaporated water is condensed in the inner side of the glass and collected through channels.

Solar Cooker. Solar Cooker using parabolic mirror or other design is equivalent to 500 Watt hot plate. Mirror of about

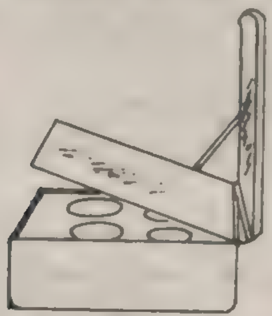


Fig. 2.7. Solar Cooker

4 Feet (4′) in diameter or $4' \times 4\frac{1}{2}$ in rectangular size focuses the heat on the black pots in cooker.

Although this cooker is easily available in the market for Rs. 350 or less, it has not become so popular. Ladies do not want to cook in open. No body can guarantee that there will always be a bright sun, specially in rainy season. So we have to develop some technique to bring that heat inside the kitchen. Then it will be a very cheap and useful cooker, and every body will like to utilise it. Solar thermal pump has been designed for deep water pumping for irrigation. One such pump is installed in Bakoli Energy Park, Delhi. A 10 litre capacity solar water heating unit cost Rs. 350. The cost of power generation from solar energy is very high.

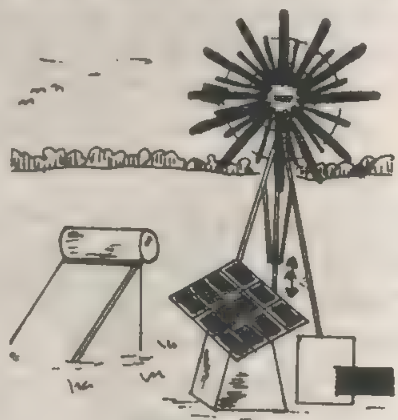


Fig. 2.9. Wind Mill

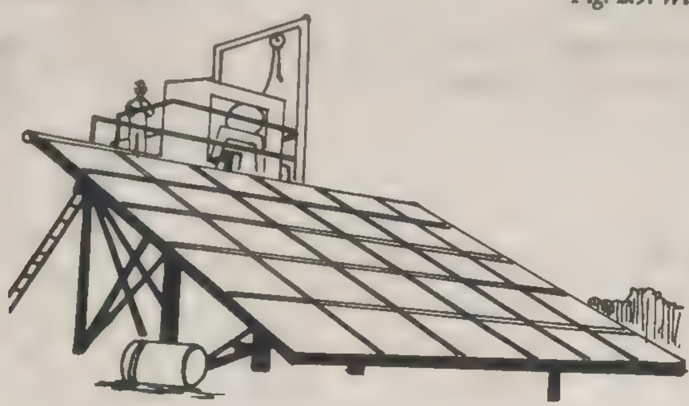


Fig. 2.8. A Solar Thermal Pump in Bakoli Energy Park, Delhi.

(4) **Wind Energy.** Wind mills are designed which are turned by wind pressure and can be used for pumping up water from ground for drinking and irrigation.

Aero-generators are designed for electricity generation.

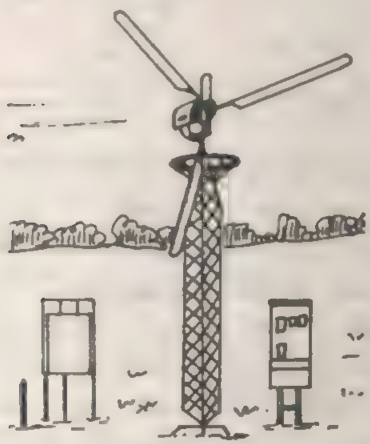


Fig. 2.10. Aero-Generator

(5) **Bio-Gas Energy.** It is a clean and cheap source of energy. The gas generated can be used for cooking and lighting. Per day about 50 kg dung of 4-5 animals is sufficient for producing 3 m^3 gas which is sufficient for cooking the food of 8-10 persons and for one light (about 60 Watts). The solution of 50 kg dung in water is taken in a cylindrical metallic vessel covered with floating cover (tomb type). It starts to generate the gas first time after 10 to 25 days. Then we can get supply of gas continually every day by adding solution of 50 kg of dung per day into vessel.

All the above said innovations are already installed at one place in 35 villages in different parts of the country as rural energy parks. You can see one such park in Bakoli Village, Delhi.

It supplies an integrated package of energy which can be used for different purposes according to need of that village. You can prepare an integrated working model of the required items in the park of your school with the co-operation and help of school authorities and local government bodies connected with the energy development.

(6) **Energy from waste.** One of the more innovative methods for producing

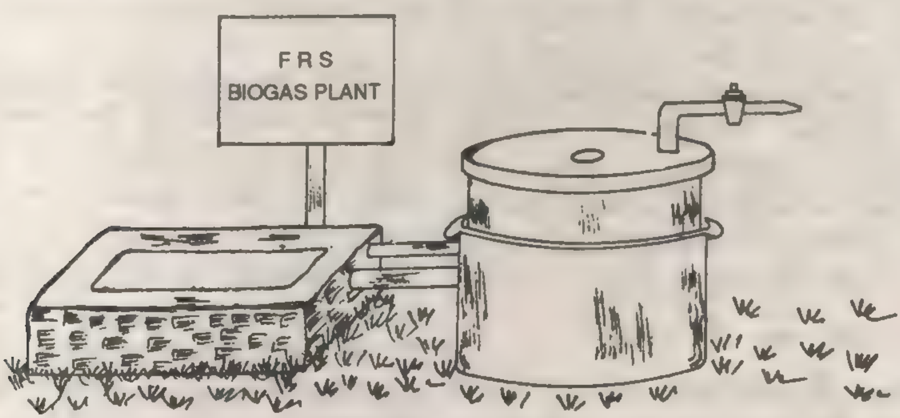


Fig. 2.11. Biogas Plant.

Fig. 2.12 An energy park set up in rural Delhi

energy is to biologically convert a mixture of municipal solid waste (MSW) and sewage sludge into a methane containing gas. This gas after refining can be used for different energy requirements.

Seeds such as those of the Chinese tallow tree and many others are renewable resources of lighting fuel and diesel fuel extender if properly refined. The whole seeds crushed and formed into fuel cakes can be used as house-hold cooking and heating fuels.

Increased industrial activity and changing concepts and standards of living generate large volumes of water and garbage consisting mainly of plastic materials, metals, paper, card board, glass, rubber, leather, textiles etc. We can profitably generate heat by incineration,leaving only a small fraction of only between 1 to 3 per cent of the initial refuse volume.

2.6. Judicious use of Energy

It may be reiterated that efforts to augument the supply of renewable energies do not in any way minimise the need to accelerate the supply of energy from all the known indigenous sources including coal, hydel and nuclear. For the most efficient use of our major fossil fuel resources, namely coal, we must include the major plants for liquification and gasification of coal which could then be used by several industries presently using oil to generate high temperatures. We must also improve the transportability of coal. Efforts will also have to be made for harnessing fusion energy which could meet part of the increasing needs in the future.

We must not waste energy but use it very economically. We should try to save water and electricity if not for others, atleast for reducing our water and electricity bills. One should use only sanctioned amount of electric power as is permitted under the law of the land. In this connection the theft of electricity should be checked and dealt with severely.

SUMMARY

1. Energy is a need for every body.

2. All electrical appliances are useless without electricity

3. Industries can't maintain their level of production if sufficient energy supplying raw materials, including electricity and petroleum are not provided to them.

4. There are limited stocks of fossil fuels.

5. Fossil fuels produce air pollution and water pollution and as such creating big environment problems.

6. Hydro energy is produced by turning turbines by water coupled with electric generators.

7. Non-conventional sources of energy are also known as continuous source of energy.

8. They include (1) Ocean energy (2) Geothermal energy (3) Solar energy (4) Wind energy (5) Bio-gas energy (6) Energy from different wastes.

9. We should explore and utilize all sources of energy, whether conventional or non-conventional.

10. Energy should not be wasted and must be used economically.

EXERCISE

1. Why is there a need for energy ?

2. What are conventional and non-conventional sources of energy ?

3. How do you generate energy by the following :

   (a) Ocean tidal.

   (b) Nuclear material.

   (c) Water.

   (d) Sun.

4. What is the name given to each of the energy obtained by different sources in Question No. 3.

5. Categorise the following sources of energy as conventional or non-conventional :

(a) Coal	(b) Petroleum	(c) Wind
(d) Water	(e) Ocean	(f) Uranium and thorium
(g) Sun	(h) Waste	(i) Bio-mass
(j) Municipal Sewage Waste.		

6. Categorise the sources of energy in Question No. 5 as stored sources of energy or continuous sources of energy ?

7. Write a short note on judicious use of energy ?

8. Explain how does the following sources generate the energy and what is the name of the energy so generated ?

(a) Wind (b) Biomass (c) Waste

9. How is water heated by solar energy ?

10. Match the sources in Column 'A' with the energy Column 'B' which the source generates :

Column 'A'	Column 'B'
1. Hydro power station	(a) Mechanical
2. Wind Mill	(b) Electricity
3. Solar Cooker	(c) Heat
4. Thermal Power Station	(d) Light
5. Photovoltaic	(e) Sound
6. Aero-generators	(f) Potential
7. Biogas Plant	(g) Kinetic

11. In how much time does a biogas plant start supplying gas for first time ?

12. What do you mean by a continuous source of energy ?

13. In what different type does the energy change from start to the end in Hydro-electric Power Station and in a Photo-Voltaic Power House ?

ACTIVITY

1. Make a Solar Cooker to be used as a Cooker/Hot Case. Make a wooden box (2′ × 2′ × 1′) with a lid. Fit a plane mirror in the lid such that heat is reflected from the mirror when the lid is opened at a particular angle and focus on a black pot with cover in the box. Your Cooker is ready. You can boil potatoes, eggs, vegetables etc. You can use it as a hot plate also.

2. Make a trip to Bakoli Village in Delhi to enjoy energy park there.

CHAPTER 3

METALS AND MINERALS

3.1. Introduction

Metals play a very important role in our daily life. Practically everything we use has either metal in it or has been made with machinery made of metals. Utensils, coins, hooks, nails, hinges,various types of tools, and a host of other things in daily use are made from metals. Electric poles, bridges, frames supporting giant buildings, elevators, ships, aeroplanes, etc., are all constructed from different metals. Through constant use, you are now so familiar with metals that you can identify them on sight. There are substances that look like metals, but they may not be metals. Thus, stainless steel, brass, gun metal, bronze, etc., are not metals inspite of their metallic appearance, these are alloys. An alloy is a homogeneous mixture of a metal with another metal or a 'non-metal'.

The term 'metal' or 'non-metal' refers only to elements. Thus, iron, zinc, copper, silver, gold, etc. are metals, oxygen, hydrogen, carbon, sulphur, etc. are non-metals. We shall not be justified in calling sand or common salt as non-metals since these substances are not elements.

Fig. 3.1. Things made of different materials.

3.2. Physical Properties of Metals

When you identify a substance as a metal, you actually consider a number of its physical properties that distinguish it from non-metals. Some of the important properties of metals are :

1. Physical State. Metals are solids at ordinary temperatures. The only exception is mercury (a liquid), which we regard as a metal on consideration of other properties.

2. Metallic Lustre. Most metals have a lustrous surface. The metallic lustre increases on polishing the metal.

Many metals lose their lustre when exposed to air for a long time. This is due to the reactions of the metal with the oxygen, moisture, carbon dioxide, etc. of air as a result of which a film of oxide, hydroxide, carbonate, etc., of the metal is formed on the surface. This film obscures the lustre of the metal and makes it appear dull. However, when the surface of the metal is scrubbed, this film is removed, and the lustrous surface underneath it again appears.

Experiment. Take a piece of iron coated with rust*. Rub it with a piece of sand paper. Note the appearance of the surface after the rust has been removed.

Some metals. *e.g.*, silver, gold, platinum, etc., retain their metallic lustre in air.

3. Hardness. Metals are usually very hard. When struck with a hammer, they do not fall to pieces. That is, they are not brittle. Glass, salt, coal, etc., are brittle. Being hard, metals cannot be cut with a knife. A few metals, however, such as sodium and potassium, are soft enough to be easily cut with a sharp knife.

Experiment. (a) Take samples of thin sheets of steel (iron), copper and lead. Try to cut these with a sharp razor blade. Note your observation.

(b) Take out a piece of sodium metal by a pair of tongs. Press it between folds of filter paper to remove the adhering oil. Now place the dried piece of the metal on a dry sheet of glass. Try to cut it with a sharp razor blade. Are you able to cut it ? Note the appearance of the freshly cut surface. Why is it more lustrous ?

4. Density. The specific gravities of metals are generally high. Only a few metals have specific gravities less than five and these are classed as light metals. Other metals with specific gravities more than five are called heavy metals. A few metals, such as sodium and potassium, are lighter than water *i.e.,* their specific gravities are less than one. Hence they will float on water.

5. Melting point. The melting point of metal is generally very high. Most non-metals melt above 100°C, among metals only sodium and potassium melt below this temperature. Iron melts at as high as 1,535°C.

6. Conductivity. Metals are generally good conductors of heat. This is why, metals like iron, copper and aluminium as well as

* *Rust is iron oxide formed on the surface of iron in moist air by the combined action of oxygen and moisture.*

their alloys are used in making cooking utensils. The best conductors among metals are silver and copper and the worst are lead and mercury.

Metals are good conductors of electricity, too. Copper and aluminium are widely used for making electrical goods and electric transmission cables. Silver is the best conductor but is very expensive as compared with copper.

7. Malleability. Metals are generally malleable. That is, they can be beaten into thin sheets. You must have seen thin foils of silver atop sweets, etc. These are made by beating silver. Gold is the most malleable metal.

An ordinary gold leaf is only 0.0001 millimetre thick ; four million of these leaves placed atop one another would make a pile only 2.5 cm thick.

8. Ductility. Most metals are ductile, that is, they can be drawn into thin wires. Gold is the most ductile metal also. One gram of gold can be drawn into a wire about 3 kilometres long.

3.3 Chemical Properties of Metals

1. Formation of oxides. Almost all metals combine with oxygen to form oxides. The case of formation of oxides, however, varies from metal to metal.

(a) Very active metals, such as, sodium, potassium and calcium are readily oxidized on mere exposure to air at ordinary temperatures. Such metals are, therefore, kept under kerosene oil to keep out air.

Magnesium, zinc, aluminium, lead, etc. are also oxidized in air. However, the thin film of oxide formed on the surface protects the metals underneath from further oxidiation. Hence, these metals do not need special precautions for storage. When required, the oxide film may be easily removed by rubbing with sand paper.

(b) Metals like magnesium, copper, zinc, aluminium, lead, etc. are converted into oxides when heated in air.

$2Mg + O_2 \rightarrow 2MgO$ (Magnesium oxide)

$2Zn + O_2 \rightarrow 2ZnO$ (Zinc oxide)

$2Cu + O_2 \rightarrow 2CuO$ (Cupric oxide)

$4Al + 3O_2 \rightarrow 2Al_2O_3$ (Aluminium oxide)

Experiment. Take a piece of magnesium ribbon, about 10 cm long. Clean it by rubbing with sand paper. Cut the cleaned ribbon into small pieces. Place the pieces of magnesium ribbon in a crucible and heat it over a low flame. Observe the changes.

The white substance left, after magnesium has completely burnt over, is magnesium oxide.

(c) Metals like copper, tin, chromium, nickel, etc. are not completely oxidized beyond the surface even on strong heating. Such metals are therefore used for coating iron articles to prevent rusting. Locks, bicycle parts, door handles, etc., are often nickel or chromium plated.

(d) Metals like gold and platinum do not form oxides under any conditions. Such metals are called *noble metals.*

2. Reaction with water. Some metals can displace hydrogen from water under suitable conditions. However, they greatly vary in their reactivity toward water.

$$Zn + 2H_2O \xrightarrow{Heat} Zn(OH)_2 + H_2$$

$$Cu + H_2O \xrightarrow{Heat} \text{No reaction.}$$

Very active metals, *e.g.*, potassium, sodium and calcium liberate hydrogen from water at ordinary temperature.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Experiment. Cut a small piece of sodium metal and dry it between folds of filter paper. Wrap it in a copper gauze which acts as a sinker. Place it in water contained in a trough and invert over it a test tube filled with water. Bubbles of a gas are evolved in a rapid stream. Soon a colourless gas collects in test tube by the downward displacement of water.

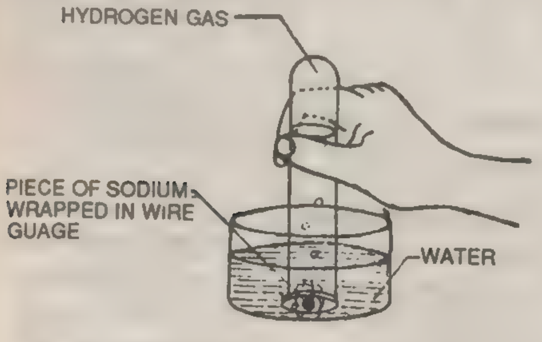


Fig. 3.2. Sodium liberates hydrogen from cold water producing sodium hydroxide in solution.

Take out the test-tube and bring a lighted match stick near its mouth. A loud 'pop" is heard and the gas begins to burn with a hardly visible flame. What is this gap ?

Add a drop of phenolphthalein to the solution in the trough. Why does it turn pink ?

3. Reaction with acids. Most of the metals dissolve in mineral acids with the evolution of a gas and the formation of corresponding salts – sulphates with sulphuric acids, chloride with hydrochloric acid, and nitrates with nitric acid.

When heated with concentrated sulphuric acid, copper, zinc, iron etc. form sulphates with the evolution of sulphur dioxide.

$$\underset{\text{Copper}}{Cu} + \underset{\text{Conc. Sulphuric acid}}{2H_2SO_4} \rightarrow \underset{\text{Copper Sulphate}}{CuSO_4} + \underset{\text{Water}}{2H_2O} + \underset{\text{Sulphur Dioxide}}{SO_2}$$

Materials like *chutney* and pickles are not stored in the vessels made of copper and iron because the acids present in the sour things react with these metals.

Demonstration. Put a little *chutney* in small utensils made of different metals and leave them over night. Observe the utensils and the *chutney* next day.

3.4. Occurrence of Metals in Nature

Minerals. The compounds of metals occurring in nature are called *minerals.*

Metals occur in nature mostly in the form of minerals in the earth's crust. Very

few minerals contains metals in the free state, *i.e.*, as simple substances. Examples of metals occurring in the free state are gold, platinum and silver. These metals are not very reacting and do not react with other substances in nature. Reactive metals, such as sodium, potassium, iron, aluminium, zinc, etc. do not occur free in nature. They occur in the minerals as their compounds, *i.e.*, in the combined state. The more common naturally occurring combined states of metals are the acids, carbonates, sulphides, etc. Besides the compounds of the metals, the minerals always contain varying amounts of rocky material. Such minerals as contain a very large amount of the unwanted rocky material, are not suitable for the extraction of metals. Those minerals from which the metal can be profitably extracted, are called *ores*. All ores are minerals, but all minerals are not ores. For example, both clay and bauxite are minerals of aluminium. However, it is bauxite and not clay which is an ore of aluminum.

Ores of some common metals alongwith the metal compounds in them are given in the table below.

Copper ores are found in Orissa, Bihar, Karnataka and Sikkim. Bauxite, the main ore of aluminium is found in Madhya Pradesh, Bihar, Orissa, Tamil Nadu, Gujarat, Kutch and Kashmir. Haematite is found in Bihar, Orissa and Madhya Pradesh.

Concentration of the Ore

The Ore usually consists of the metal or its chemical compound mixed with large quantities of rocky impurities, *e.g.*, sand, clay, limestone, etc. These impurities present in the ore are called **gangue.** *The process of removing gangue from the ore is called concentration of the ore.* For this purpose, the big lumps of ore are first crushed to smaller pieces in *jaw crushers* and *grinders* and then finely powdered in *ball mills.* The two most common methods for concentration of the finely powdered ore are the gravity separation and the froth floatation process.

Extraction of the metal from the ore

The extraction of the metal from its ore depends upon the quality (constituents) of the ore. The following are few methods :

Ores of Some Common Metals

	Metal	*Name of the ore*	*Type of compound*	*Composition*
1.	Iron	Heamatite	Oxide	Fe_2O_3
2.	Copper	Copper pyrites	Sulphide	Cu.S.FeS
3.	Silver	Argentite	Sulphide	Ag_2S
4.	Aluminium	Bauxite	Oxide	$Al_2O_3.2H_2O$
5.	Lead	Galena	Sulphate	PbS

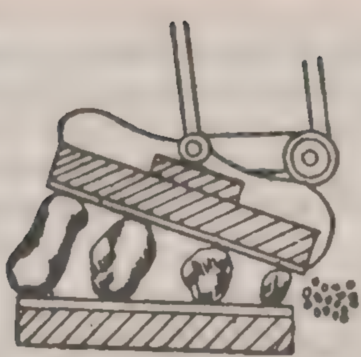


Fig. 3.3. Jaw crushers

(1) Roasting. The concentrated ore of copper is heated in the presence of air. This process is called *roasting.* The roasted ore is then heated with carbon to give copper metal.

(2) Calcination. It is the process of heating the ore strongly either in the limited supply or in the absence of air.

(3) Chemical reduction

(a) *Smelting.* The process of involving the extraction of metal from its oxide ore in molten form is termed *smelting.*

(b) *Electrolytic reduction.* Oxides of very active metals like Calcium, Magnesium etc. cannot be reduced by carbon. Such metals are prepared by electrolysis of their fused salts.

(4) Refining. Metals obtained above are generally impure and are refined by one or more of the following ways :

(a) *Distillation.* For volatile metals like Zinc and Mercury.

(b) *Oxidative refining.* Metals like Iron.

(c) *Electro refining.* The impure metal is made anode and a thin plate of the pure metal is made cathode in an electrolytic cell containing a suitable electrolyte. When a circuit is charged, metal from anode is deposited on the cathode through the electrolyte.

3.5. Corrosion

What is Corrosion ? In moist air, iron is rapidly covered with a brown, flaky substance, called *rust.* Rust is formed by the action of water, oxygen and carbon dioxide present together in the air. It consists of hydrated ferric oxide, $Fe_2O_3.3H_2O$. The loose coating of rust does not prevent the underlying iron from further rusting, since air and moisture can pass through it. In course of time, the iron articles may be completely destroyed due to rusting (Fig. 3.4). Similarly, copper is covered with a greenish substance, called *verdigris,* when kept exposed to air for a considerable time. In this process, copper is converted into a useless substance which means wastage of copper.

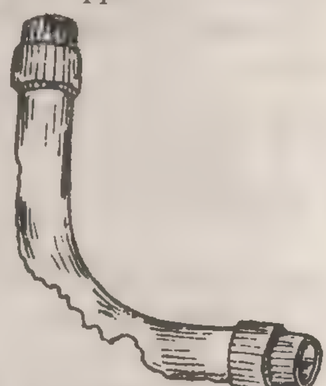


Fig. 3.4. Rusting of an iron pipe.

The slow rusting or wasting away of a metal is called **corrosion.**

Corrosion of metals may also occur in water containing dissolved acids, alkalies, etc. Aluminium is rapidly corroded in

contact with water containing dissolved salts, sodium carbonate, etc. Copper, Zinc and many other metals are corroded by acid solutions.

Economic Aspects of Corrosion

Corrosion of iron and other metals causes great economic loss. About one-tenth of the total annual world production of iron is destroyed by corrosion each year. The loss was much greater in former times. Thus of the 1,860 millions tons of iron and steel produced during 1870-1920, 660 million tons or more than a third, was lost by corrosion. Corrosion of vital parts often necessitates the closing down of chemical plants. Rusting of iron causes disaster by eating into grinders, pipes, hulls, aeroplane wings, etc. Little wonder, therefore, that huge sums of money are being spent every year on measures for the prevention of corrosion of metals.

Prévention of Corrosion

Corrosion of metals is prevented by coating the surface with a suitable material. The various methods in use are :

1. Coating with oils. Agricultural machines and various other machines and instruments made of iron and steel are kept smeared with oil when out of use. The oil coating cuts off the contact between metal and air whereby the corrosion is prevented.

2. Coating with paints. The best paints for iron are made by mixing 'boiled' linseed oil with a suitable pigment such as red lead (Pb_3O_4) or red oxide (Fe_2O_3). Bridges, railway-coaches, steel furnitures etc. are painted to prevent rusting. When 'dry', the oil forms a horny impenetrable coating over the metal.

3. Enamelling. Kitchen utensils of enamelware, *e.g.*, cup, plates, basins, dishes, are made of iron and covered with a glass-like coating of boro-silicates. *The process of imparting the boro-silicate coating is called enamelling.*

4. Coating with another metal. Metals are often saved from corrosion by coating their surface with a suitable metal. The metallic coating can be applied mechanically or electrolytically. Its three important processes are :

(a) **Galvanizing.** *The process of depositing a very thin layer of zinc on iron sheets is called galvanizing.* The resulting sheets are known as *galvanized iron sheets.* Before galvanizing, the iron sheets are thoroughly cleaned with an acid. These are then dipped in molten zinc and then passed through hot rollers to remove superflous zinc. A uniform, thin deposit of zinc is thus obtained on the sheets.

Galvanized iron sheets are used for roofing and for making buckets, bath tubs, gutters, etc.

(b) **Tinning.** The organic acids present in foodstuffs corrode the surface of utensils made of copper, brass etc. Further, the metallic salts produced mix up with eatables and cause food poisoning. To prevent this, kitchen utensils are often covered with a thin layer of tin. This process is called *tinning.*

The utensil to be tinned is thoroughly cleaned by scrubbing with sand. It is then

heated over glowing charcoal. Some solid ammonium chloride is sprinkled over its hot surface, which is further cleaned by the action of hydrochloric acid produced by the decomposition of ammonium chloride.

$$\underset{\text{Ammonium chloride}}{NH_4Cl} \longrightarrow \underset{\text{Ammonia}}{NH_3} + \underset{\text{Hydrogen chloride}}{HCl}$$

A little tin is now rubbed on the surface which immediately melts. The molten tin is uniformly distributed all over with a rag. The hot vessel is then cooled by plunging in cold water when the deposit of tin firmly adheres on the surface.

(c) **Electroplating.** The process of deposition of a metal coating on a surface with the help of electricity is called *electroplating.* Copper utensils are often electroplated with silver to prevent corrosion and improve the appearance. Iron and steel articles, *e.g.,* locks, bicycle handles, rims, etc., are electroplated with tin, chromium, or nickel to prevent rusting.

The article to be elctroplated is thoroughly cleaned. It is then suspended in a solution of the salt of the metal, to be deposited, *e.g.,* potassium argento-cyanide [$KAg(CN)_2$] for silver-plating. A strip of rod of the metal to be deposited, *e.g.,* silver is also suspended in the solution. The article is connected to the negative terminal of the battery and the pure metal strip to the positive terminal. As the current flows through the solution, the pure metal deposits on the articles in a smooth, uniform coating.

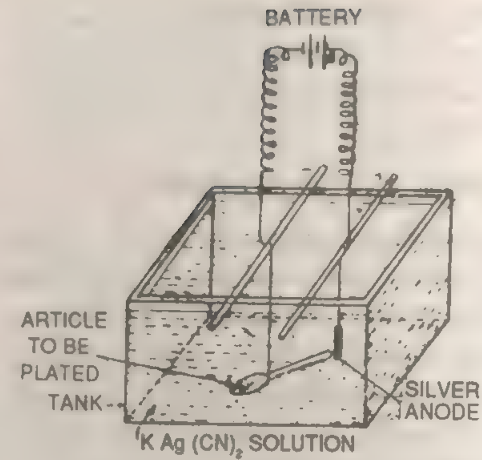


Fig. 3.5. Silver-plating of articles.

3.6. Alloys

Introduction. Metals differ from non-metals in their solubility. While most non-metals are soluble in water or other liquid solvents, no metal is soluble in any thing. Metal is soluble with another metal. *Such metallic materials consisting of two or more metals, are called alloys.* Thus, brass is an alloy of copper and zinc and bronze is an alloy of copper and tin. Many alloys contain small quantities of such non-metals as carbon, phosphorus or silicon. Steel, for example, is an alloy of iron and carbon (it may contain other metals also).

The purpose of an alloy is to produce certain properties which none of the individual ingredients has. Hence, we can say, alloys are made to improve the working properties of metals. Thus, gold is made harder by alloying copper with it. Iron is alloyed with nickel to make it tough and with chromium to make it rustless (stainless steel). Lead and tin are alloyed to obtain a material that melts readily on heating. This material is called *solder*. The fuse

wire used in electricity is also an alloy of lead and tin.

Preparation of Alloys

The two commonly employed methods for the preparation of alloys are :

1. Fusion or melting. The metals are taken in proper proportion and melted. The fused mass is thoroughly stirred with a charcoal stick. In case, one of the metals melts at a higher temperature than the other one, the high melting metal is first melted and the other one is added to the molten metal in small lots at a time and stirred.

2. Compression. Some alloys are made by compressing the mixture of component metals in a powdered form, taken in proper proportion.

Alloys of Aluminium

Alloys of aluminium are light yet as strong as steel. The combination of lightness and strength makes these alloys very useful in many industries. Two important alloys of aluminium are dural or duralumin and magnalium.

Duralumin. This alloy consists of about 95 per cent aluminium, 4 per cent copper, 0.5 per cent manganese and 0.5 per cent magnesium. Though half dense as steel, it is nearly as strong as steel. Besides, it is very ductile and resistant to corrosion. It is used in the construction of aeroplanes.

Magnalium. It is an alloy consisting of 98 per cent of aluminium and 2 per cent of magnesium. It is hard, tough and light. While aluminium sticks to the lathe, tools and files, magnalium is free from this defect. Thus, it can be easily worked on the lathe. It is used in the construction of aeroplanes, pistons of motor engines, balance beams and light instruments.

Alloys of Copper

Copper forms a large number of industrially useful alloys. Of these, brass and bronze are the most important.

Brass. This is an alloy consisting of 60-80 per cent copper and the rest zinc. It has a fine yellow colour. When the proportion of copper is low, the brass is harder, paler in colour and more brittle. A higher proportion of copper renders brass softer and brighter in colour.

Brass is widely used for making cooking utensils, water taps, door handles, condenser tubes, cartridge cases, castings and band instruments.

Bronze. This is an alloy of 75-90 per cent copper and the rest tin. It is prepared by melting together the two metals in the required proportion. Bronze is very tough and is used for making parts of machinery which have to withstand great shocks, *e.g.*, ship propellers. It is also used for making statues and other works of art. In some countries bronze is used for coinage.

Alloys of Silver

Silver is a lustrous, white metal which is not tarnished in air. Hence, it is widely used for making coins, ornaments and silverware. However, it is too soft to be used as such for making these articles. It is

made harder and tougher by alloying it with copper and other metals. An alloy commonly employed for making coins and silverware consists of 92.5 per cent of silver and 7.5 per cent of copper. The coinage alloy said to be used in Great Britain has the following composition :

Silver 50 per cent, Zinc 5 per cent, Copper 40 per cent and Nickel 5 per cent.

SUMMARY

1. Elements have been divided into two broad groups : metals and non-metals.

2. Some physical properties of metals are : metallic lustre, hardness, high specific gravity, high melting point, good thermal and electrical conductivity, malleability (ability to be beaten into thin sheets), and ductility (ability to be drawn into thin wires) etc.

3. Except the noble metals (gold and platinum), all metals form their oxides, directly or indirectly.

4. Most metals displace hydrogen from water. Very active metals can do so at ordinary temperature, less active metals displace hydrogen from steam at high temperatures.

5. Noble metals occur in nature in the free state ; other metals occur in the combined state.

6. Those minerals from which the metal can be profitably extracted are called ores.

7. Big lumps of ore are first crushed to smaller pieces in jaw crushers or grinders.

8. Copper metal is extracted from its concentrated ore by the method of roasting, iron from its concentrated ore by blast furnace method and aluminium is extracted from its concentrated ore by a special method which is known as electrical method.

9. Refining : metals are refined by (i) distillation/or (ii) oxidative refining /or (iii) electro-refining.

10. The slow rusting or wasting away of a metal is called corrosion.

11. A metal may be prevented from atmospheric corrosion by cutting off its contact with air.

12. Some common methods for preventing corrosion are : coating with oil, coating with paints, enamelling and coating with another suitable metal.

13. The process of depositing a thin coating of zinc on a metal surface is called galvanizing and of depositing tin is called tinning.

14. In electroplating, the article is suspended in a tank containing solution of a salt of the metal to be deposited on it and connected to the negative end of the battery. A strip or rod of pure metal to be deposited is also suspended in the solution and connected to the positive end of the battery.

15. Alloys are metallic material consisting of two or more metals.

16. Some alloys may contain such non-metallic constituent also, *e.g.*, carbon, silicon and phosphorus.

17. Alloys are commonly made by melting together the various components in proper proportion and cooling the resulting mass.

18. Alloys of aluminium are light, tough as steel, very ductile and resistant to corrosion. Two most important alloys of aluminium are duralumin (Al 95%, Cu 4%, Mn 0.5% , Mg 0.5%) and Magnalium (Al 98%, Mg 2%). These are used for making aeroplanes.

19. The most important and widely used alloys of copper and brass (Cu 60-80%, Zn 40-20%) and bronze (Cu 75-90%, rest tin).

20. Silver is alloyed with copper to make it harder and tougher.

QUESTIONS

1. Give a brief account of the important physical properties of metals.

2. Give two examples of metals that are :

(a) not oxidized in air even on strong heating ;

(b) readily oxidized in air ;

(c) lighter than water ;

(d) good conductors of electricity ;

(e) do not react with water ;

(f) found in the free state in nature.

3. How would you experimentally prove that the reaction of sodium with water results in the liberation of hydrogen and formation of an alkali ?

4. What do you understand by the following terms :

(a) Mallebility	(b) Ductility
(c) Mineral	(d) Ore
(e) Aqua regia	(f) Noble metals
(g) Light metal	(h) Heavy metals

5. Give the names of the metals which can be extracted from the following ores. Also mention the metal constituents present in them :

Ore	Metal	Metal Constituents
(i) Haematite	....	....
(ii) Bauxite	....	....
(iii) Copper Pyrites	....	....
(iv) Magnetite	....	....

6. What is corrosion ? Explain with suitable examples.

7. Describe in brief the common methods for preventing corrosion of metals with suitable examples.

8. What is an alloy ? Give the names of some alloys used in making household articles.

9. Describe the composition properties and uses of the following alloys :

(a) Duralumin (b) Brass (c) Bronze.

10. How is bicycle handle made of steel prevented from rusting ?

11. *Fill in the blanks :*

(a) $Na + O_2$ — ....

(b) $3Fe + 4H_2O$ — .... + ...

(c) $Fe_2O_3 + 3CO$ — .... + ...

(d) $2Al(OH)_3$ — .... + ...

ACTIVITY

1. Collect a few easily available metals and study their properties such as, conductivity, malleability, density etc.

2. To collect some alloys and study their special uses.

3. Melt in an iron crucible, lead and tin in the ratio 1 : 2 by weight, on the flame. Pour into cold water. You get solder alloy. Use it as solder.

CHAPTER 4

MAN MADE MATERIALS

Introduction

About 100 years ago, every thing of daily use was made from wood or metal, wool or cotton, silk or stone. In 1865 a chemist *Birminghan Parkes* was successful in discovering a new substance named "Parkesite" after his own name. He treated cellulose (cellulose is the basic substance of wood and cotton wool) with nitric acid. When nitro-cellulose was mixed, a hard horn like substance was formed.

Cellulose was used for all sorts of things, even for dolls and camera films. But it had one defect. It was highly inflammable, *i.e.*, it caught fire very quickly.

The new material cellulose acetate (mixing cellulose with acetic acid) was discovered by scientists named Cross and Berean. Then this new substance was used for producing a new kind of cloth called at first *artificial silk* and later *rayon*. But now it is replaced by *nylon*. Nylon is also plastic but it is stronger and more satisfactory than rayon. So nylon and rayon have no connection with silk.

4.1. Synthetic Fibres

These fibres are strong creases resistant. Fibres are damaged by high temperature and, therefore, should be ironed carefully. Garments stitched from these fibres do not allow the air to pass through them and are not very comfortable for summers. Some of the man made common synthetic fibres are as follows :

(i) **Rayon.** It is an artificial silk. It is prepared by the natural product cellulose, obtained from wood pulp. It is mostly used for making car tyre, cords, stockings, light weight sweaters etc.

(ii) **Nylon.** It is manufactured by the polymerisation of hexamethylene diamine and adipic acid. It is used in making bristles of brushes, electrical insulators, climbing ropes etc.

(iii) **Terylene.** Its fibre appeared after the discovery of nylon. It is a strong thermoplastic and very resistant to action of chemical and biological agents. It dries very quickly. When mixed with cotton, it is called *terycot* or *terycotton*. Similarly, the fibre mixed with wool is called terywool.

Cotton and wool are natural fibres. They protect the body from the atmospheric heat or cold. Dresses made from these fibres do not retain crease and sometimes shrink on washing. Dresses fabricated from their material look beautiful, but are very expensive.

Distinction between wool, cotton, silk and artificial fibre

1. **Cotton fibre** burns vigorously, with a smell of burning paper, and does not form any bead.

2. **Artificial fibre** burns slowly. Here, the fibre melts to form a bead.

3. **Wool and Silk** burn, but not vigorously. They do not form a bead and give a smell of burning feather.

4.2. Types of plastics

There are two distinct types of plastics, one is called *thermo-plastics* and other *thermo-setting plastics.*

(1) **Bakelite.** Bakelite is an important variety of thermo-setting plastics. During the year 1916, it was used for making number of substances, such as electric switches, door handles, telephones, etc. But it had one defect, its colour was black. A new substance *urea* which was equally good as bakelite was choosen to replace bakelite. Soon after this, many other substances almost like urea, were found. *Plastic age* began from 1925.

(2) **Polyvinyl Chloride (PVC).** This is the most versatile and cheap plastic. It is obtained as a white powder. The powder is processed to give products ranging from soft rubbery materials to hard sheets. It is used to make gramophones records, hand bags covering sheets for suitcases etc. Recently pipes are prepared from PVC.

(3) **Polystyrene.** It is one of the cheapest plastic. Articles made from their plastic give a tinkling metallic sound. It is hard and brittle. It is used for manufacturing packing materials.

(4) **Perspex.** This is an acrylic plastic. It forms transparent sheet. It is unbreakable and, therefore, used for windows in aircrafts, wind screen of cars and telephones etc. It can be dyed in different colours.

(5) **Celluloid.** It is made by treating cellulose with nitric acid. The formed product cellulose nitrate is treated with camphor to give rise to plastic celluloid. It is used for making combs, soap boxes etc.

Use of Plastics in Daily Life

A few of the articles of daily use made from plastics are : nylon stocking, tooth brushes, electric switches, buckets, tumblers, rain coats, door handles, telephones, fountain pens, etc.

4.3. Glass

Glass is a viscous liquid that has been cooled so far below its melting point and has become apparently solid. Fused silica and metallic borates form glasses.

Glass is made by fusing clean white sand sodium or potassium carbonate lime stone or lime, and litharge (lead monoxide) or led lead in fireclay pots at about 1,400°C. Then, the mixture is allowed to cool slowly. Common glass has the approximate composition $Na_2O.CaO.5SiO_2$. Traces of manganese dioxide are added to neutralise the green colour due to the iron as an impurity.

Ordinary glass and soft laboratory glass consist mainly of sodium and cal-

Fig. 4.1. A few of the plastic articles of daily use.

cium silicates. Pyrex and modern hard glasses which are heat resisting, contain boro silicates, much silica and little alkali. Various coloured glasses are made by adding different metallic compounds to the molten glass.

Varieties of Glass and their Uses

1. (i) *Soft Glass.* It is the common variety employed for making ordinary glass ware and glass plates.

(ii) *Hard Glass.* It is used for making hard glass apparatus.

(iii) *Jena Glass.* It is used for making glass apparatus which are resistant to heat, chemicals and shock.

(iv) *Pyrex Glass.* It has the properties similar to Jena glass.

(v) *Optical Glass.* It is used for making optical instruments, *e.g.*, microscopes.

Fig. 4.2

(vi) *Safety Glass.* It is used in making automobile wind shields.

(vii) *Glass Wool.* Glass being a thermal insulator is wrapped round various articles in the form of glass wool.

4.4 Ceramic

It is a material made of clay. It is obtained by baking clay at a very high temperature. Ceramic articles are covered with glaze to make them water resistant. It is used for making tiles, potteries toys, bricks etc.

4.5. Soaps

Soap was the first detergent known from Roman times and it is still one of the commonest.

The sodium or potassium salts of higher fatty acids, are called *soaps.*

Oil (Fat) + Base --- Soap + Glycerol

Modern commercial soaps contain perfume, colouring matter, antiseptic disinfectant and bleaching material.

Soaps have two advantages :

(1) Water containing dissolved calcium and magnesium salts (Hard Water) precipitates soap as insoluble salts.

(2) In acid solution, the free fatty acids are precipitated and therefore, do not prove to be effective cleansing compounds.

Cleansing action of soap

Soap has cleansing property because, it can emulsify fats and oils. It converts them into a suspension of tiny droplets in water.

Synthetic detergents :

The sodium salts of sulphuric acid or alkyl hydrogen sulphate are called *detergents.* These are, generally, used for washing and cleaning purposes. They have better wetting and cleaning power.

To compare the properties and action of soap and detergent

Take two beakers A and B. In A, take synthetic detergent and in B soap. (Prepare both the solutions in hard water).

While washing the dirty cloths, you will observe the detergent solution cleanses the cloth well ; on the other hand, soap solution does not. This is due to the reason that detergents do not lose their washing properties in hard water.

4.6. Fertilizers and Manures

(1) **Fertilizers.** Chemical salts or chemical substances containing the necessary plant nutrients are called *fertilizers.*

(2) **Manure.** A natural substance obtained by the decomposition of animal excreta or plant residue is called *manure.*

Types of Fertilizers

(1) **Single fertilizer.** They are in the form of sodium nitrate, ammonium nitrate, ammonium sulphate and urea. These fertilizers are used as *nitrogenous fertilizers,* while superphosphates are used as *phosphoric fertilizers* and similarly, potassium chloride for *potassium fertilizers.*

(2) **Mixed fertilizers.** These are potassium nitrate (NK), ammonium hydrogen phosphate (NP) and, thus, combine two out of three major plant nutrients *i.e.,* N, P, K.

There are large-scale industries manufacturing huge quantity of fertilizers in our country. The main centres of manufacturing units are Nangal (Punjab), Sindri (Bihar), Rourkela (Orissa), Bombay (Maharashtra), Gorakhpur (Uttar Pradesh), Durgapur (West Bengal) etc.

Fertilizers are used to meet the deficiency of the nutrients in the soil and to increase the crop yield.

4.7. Pesticides

An organic or inorganic substance, which is used to destroy or inhibit the action of plant or animal pests, is known as *pesticide.* The pesticides are DDT, BHC, Gammexane, Zinc phosphide, Methyl paratheon. These can be used in different forms such as dusts, sprays or as gas. Almost all pesticides are toxic to man, hence demands utmost care in their use.

SUMMARY

1. Synthetic fibres are plastic, which have been specially processed to form (i) Rayon ; (ii) Nylon ; (iii) Terylene.
2. Cotton and wool are natural fibres.
3. Plastics are substances, which can be squeezed, pressed and moulded into any shape for a considerable time.
4. Cellulose acetate is the basic substance for all the plastic things.
5. Many objects like buckets, mugs, electric switches etc. are made of plastics.
6. There are two distinct types of plastics :
   (i) Thermo-plastic (ii) Thermo-setting plastic.
7. Common plastics are :
   (i) Bakelite (ii) Polyvinyl Chloride (PVC) (iii) Polystrene (iv) Perspex (v) Celluloid.
8. Glass is a homogeneous mixture of some substances such as sand, soda-ash and lime stone, etc.
9. Ordinary glass and soft laboratory glass consist mainly of sodium and calcium silicates.
10. Coloured glass is produced by adding different metallic compounds to molten glass.
11. Different types of glass are used for different purposes.
12. Ceramic is obtained by baking clay at a very high temperature.
13. Soap was the first detergent. It cleanses because it emulsify fats and oils.
14. The sodium salts of sulphuric acid or alkyl hydrogen sulphate are called detergents.
15. Chemical fertilizers or manures are added in the soil to increase its fertility and also, for the healthy growth of plants.
16. There are two types of fertilizers :
    (i) Single fertilizers (ii) Mixed fertilizers.
17. Our country have production of large quantity of fertilizers.
18. An organic or inorganic substance, which is used to destroy or inhibit the action of plant or animal pests is known as pesticide.
19. The pesticides are DDT, BHC etc.
20. Almost, all pesticides are toxic to man, should be handled with utmost care.

QUESTIONS

1. What are plastics ?
2. Define – Nylon, Rayon ?
3. How are synthetic fibres superior to cotton fibres ?
4. Give two uses of each of the followings :
   (i) Polyvinyl chloride (PVC).
   (ii) Perspex.
5. Is glass a compound with definite composition ?
6. What is Pyrex glass ?
7. Write a short note on varieties of glass and their uses.
8. How is ceramic obtained ?
9. Give reasons :
   (a) Synthetic detergents form froth in both soft and hard water.
   (b) The consumption of soap increased if, hard water is used for laundry ?
10. Write the names of atleast two compounds used as fertilizers ?
11. Distinguish between :
    (a) Soap and detergent.
    (b) Fertilizer and manure.
12. Name the insecticides.
13. What are the pesticides ?
14. Name five main centres of fertilizer production in our country ?
15. Mention the compounds to be added for imparting the following colours to the glass :

Colour	Compound to be added
(a) Green	....
(b) Orange red	....
(c) Dark blue	....

16. Fill in the blanks :

(a) .... and .... are examples, of natural fibres.

(b) Cotton is a .... fibre.

(c) Glass is a ..... of some substance.

(d) Reaction of fat and a base to form glycerol plus sodium salts of the fatty acid is called ....

(e) Fertilizers having more than one primary nutrients are called ....

ACTIVITY

1. Observe and identify various man made materials and their uses.
2. Burn pieces of cotton fibre, nylon, woolen and observe the differences.
3. Collect different types of plastics and study their physical properties.
4. Compare the cleaning effect of soap and detergent.

CHAPTER 5

FORCE AND PRESSURE

5.1. What is Force ?

It is a matter of common experience that we either pull or push a door to open or to shut it. In cricket we push our bat to hit the ball and we pull our hands to catch the ball. We push or pull the foot-ball to move it or to stop it. Thus we find it is necessary to apply push or pull to change the state of rest or motion.

Fig. 5.1. A cricketer hitting the ball.

So force is a push or pull which changes or try to change the state of rest or motion.

You and your friends can move a hand driven rikshaw at rest by applying a force. But you can't move a truck at rest by applying the same force. Similarly you can stop a moving rikshaw by applying a force but at the same time a truck in motion cannot be stopped by you by applying your physical force.

Fig. 5.2. A cricketer catching the ball.

The force has magnitude and direction both and as such it is called *vector quantity.*

Move a heavy wooden block by using a spring balance as shown in Fig. 5.3.

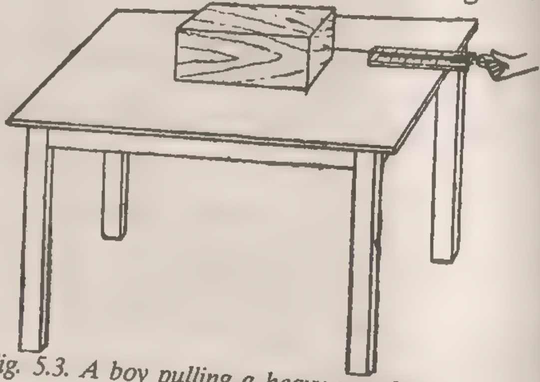


Fig. 5.3. A boy pulling a heavy wooden block by a spring balance placed on a table.

The reading of spring balance is the measure of the magnitude of the force and the direction of motion of the body gives the direction of the force.

The S.I. (International System of Units) Unit of force is *Newton (N)*. It's *cgs* unit is *dyne*. The spring balance mesures the force in gramme weight (g. wt.) or in kilogramme Weight (Kg Wt.)

$$1 \text{ g wt} = 980 \text{ dyne}$$

and $$1 \text{ Kg wt} = 9.8 \text{ Newton}$$

If a force (F) applied on a body of mass (m) set it in motion, the acceleration (a) is produced in it which is given by

$$a = \frac{F}{M}$$

or $$\boxed{F = ma}$$

Example. A force of 2.5 N acts on a body of mass 25 Kg. Find the acceleration of the body.

Solution. $F = 2.5$ N, $m = 25$ Kg. $a = ?$

By $$F = ma$$

$$2.5 = 25a$$

$$\therefore \quad a = \frac{2.5}{25}$$

$$= 0.1 \text{ ms}^{-2}$$

The weight of a body is defined as the force with which it is pulled towards the centre of the earth,

$$W = mg$$

where W = Weight of the body.

m = Mass of the body.

g = acceleration due to gravity.

The value of acceleration due to gravity on a planet or a satellite is constant at a place. Its value on average is taken as 9.8 ms^{-2} for earth and 1.6 ms^{-2} for moon. A body of mass 4 Kg will weigh $4 \times 9.8 = 39.2$ N on earth and $4 \times 1.6 = 6.4$ N on moon. So weight of a body vary from place to place but its mass remains constant.

5.2 Graphical Representation of Forces along a Straight Line

Addition and subtraction of forces along a straight line :

Let us suppose that we have to push a big stone. If only one boy pushes the stone, he may find it hard. If, however, two or more boys together push the stone in the same direction, they will be able to push the big stone more easily. They will also be able to push it faster.

What will happen if two boys push the big stone in opposite directions ? They will cancel the effort of each other and the big stone may not move at all.

Have you seen a tug of war ? This game is quite common in schools and is played by big and small children alike.

Each team tries to pull the rope towards itself. When the two pulls are equal, the rope does not move and the central mark does not shift. However, when the pull exerted by one team is greater than the pull exerted by the other, the central mark moves towards the side which exerts a greater pull and it is said that the team to whose side the central mark moved has won the tug of war.

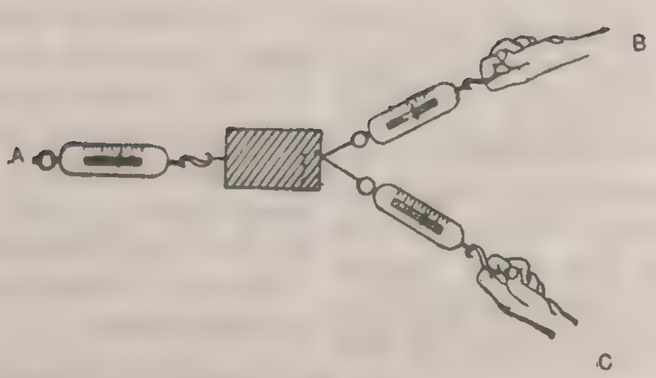


Fig. 5.4

(i) *Forces applied at the same point in the same direction add to one another.* The total force on the point is the sum of all the individual forces acting on it, separately.

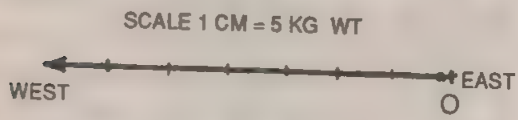


Fig. 5.5

(ii) If two forces act at *the same point in opposite direction,* the net force on the point is the *difference* between the two forces.

Activity 5.1

Set up your apparatus as shown in Fig. 5.4. With the help of two friends, arrange to pull the balances A, B and C so that the small metal string does not move.

Now record the values of B, C and A, you will observe that :

(a) Pull A=Pull B+Pull C

(b) Pull A–Pull B=Pull C

What do you conclude from this activity ?

You will realise now that in order to describe a force it is necessary to :

(A) give its size or the magnitude, and

(B) to point the direction in which the force is acting.

We can, therefore, describe a force by an *arrow.* The length of the arrow would be equal to the magnitude of the force and the direction of the arrow would show the direction in which the force acts. For example, a force of 35 Kilogram weight acting towards west can be represented by taking a ray pointing to the west and marking a point 7 cm from the starting point O as shown in Fig. 5.5. We have chosen the scale as 1 cm=5 Kilogram weight.

The forces are of several kinds – as gravitational force, magnetic force, electric force, frictional force etc. We have already discussed in part I (6th Class Book) about these forces.

5.3. Thrust and Pressure

Vehicles are prohibited over some pedestrian bridges. One might say that a

vehicle is much heavier than a man and as such the structure of the bridge might crash under its weight. True it is, but, as is often the case with such bridges, the number of persons passing over the bridge at a certain instant, together might weigh much more than a single vehicle, yet it does not crash under their weight. Why ?

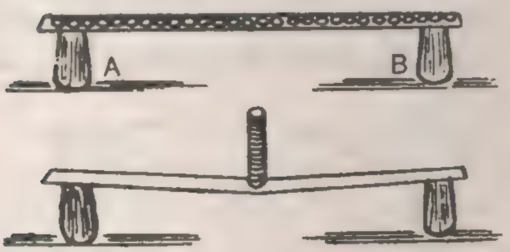


Fig. 5.6. Strip bends when coins are placed one over the other.

Let us try to understand the problem by scaling it down to a simple experiment. Place a wooden strip over two similar supports, say glass tumblers. Place a number of 10 paise coins side by side over the strip. It may take as many as 30 or 40 coins to cover the strip from one end to the other, yet it may not bend appreciably under them. Now try to place them over the other somewhere in the middle of the span and watch. Bending of the strip starts even under the weight of half the number of the coins and if the strip is not strong enough, it might break if all the coins, which were spread over its entire, length, are put together.

Now let us analyse what happened. When the coins were spread over, the total downward force on the strip due to their weight was the same as it would have been if they were placed at one point. But in the first case it was distributed over its entire span so that the force on the area under one coin was only equal to the weight of a single coin, but in the latter case the force over that area was increased many fold which caused the bend in the strip, ultimately crashing it.

In case of the vehicle, the weight is concentrated over a smaller area while the persons who cross the bridge are spread over the entire span : as such it does not crash under their weight. If all the persons collected together at one spot, the efffect would be otherwise.

This clears up one very important fact that effect of force depends upon the area over which it acts. To differentiate between the total force acting on a body and the force acting per unit area we have, therefore, to use two distinct terms.

Total force acting over a body is called the *thrust.* Thrust can be expressed in the unit as force is expressed, *i.e.,* in dynes or gramme weight etc.

Force acting over a unit area is called the *pressure.* We can say that pressure is the thrust per unit area.

Pressure is, therefore, expressed in units of force per unit area.

If a bucket of water is filled with 5 Kg of water and has a base area of 500 sq cm then the pressure on the base is

$$=\frac{5000}{500}$$

$$=10 \text{ g wt per sq cm.}$$

Some other units commonly used to express pressure are the following :

Kg/m²=Kilogram wt per sq metre

Kg/cm²=Kilogram wt per sq centimetre

Dynes/cm²=Dynes per sq centimetre.

Newton/m²=Newtons per sq metre.

We often speak of pressure as so many grammes. What we really mean is so many grammes per square centimetre. In the common language, we shorten our expression by omitting the words per square unit area.

It should be borne in mind that the corresponding unit of area and pressure must be consistent. If area is expressed in sq cms. the pressure must be in gms wt or Dynes per sq centimetre.

Where thrust is uniformly distributed over a surface, we can always work out the pressure by the following relation :

$$\boxed{\text{Pressure} = \frac{\text{Thrust}}{\text{Total area}}}$$

Thus, if we place a metal cube with sides 10 cm each and its weight is 10 Kg on the table then its thrust is 10 Kg wt, while pressure is $\frac{10}{10 \times 10}$, *i.e.*, 0.1 Kg wt per sq cm and it is uniformly distributed.

if there is a heap of sand, also 10 Kg in weight, it will exert the same thrust of 10 Kg wt over the table, but its pressure is not 0.1 Kg/cm². Since it is not uniformly distributed as in case of the metal cube. It varies from point to point, depending upon the matter over each point.

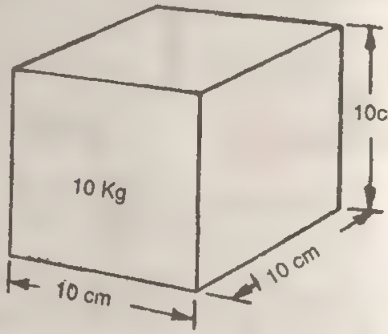


Fig. 5.7

In such cases we do not deal with pressure per unit area but we very often speak about the pressure at a point which is equal to the thrust over a very small area surrounding the point divided by the area.

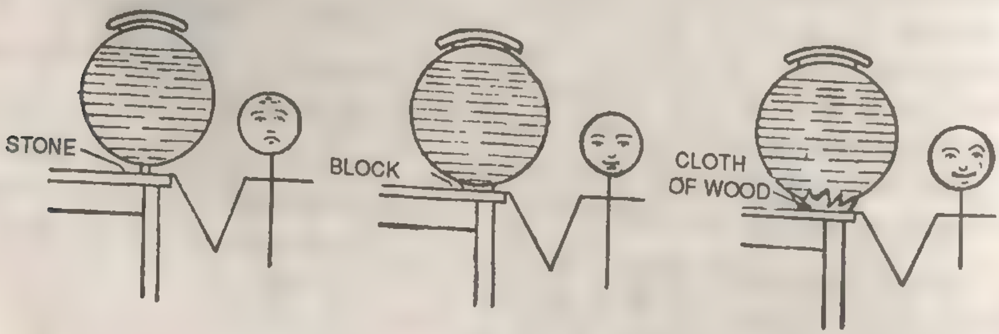


Fig. 5.8

The difference between pressure and thrust can be made clear by the following more typical examples from our daily life.

(1) Take a heavy vessel, say a big *lota* full of water and place it over a small pointed stone placed over your palm on the table. It hurts.

Repeat the same experiment but this time, instead of the pointed stone place a flat piece of wood, say 2 sq cm in area, on your palm. It hurts less.

Repeat the same experiment again, now placing a soft cloth pad ring to place the *lota* on your palm ...... this time it is the least uncomfortable. That is why the porters use cloth pad rings when they lift the loads on their heads.

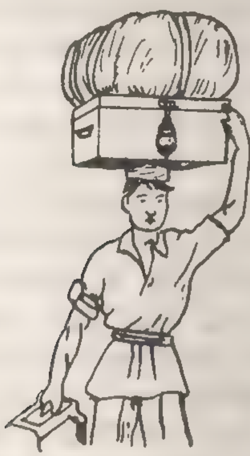


Fig. 5.9

(2) A knife is able to cut through an apple because the thrust of the hand exerts very large pressure at the edge, the edge being very narrow. The cut over the area, consequently is very narrow.

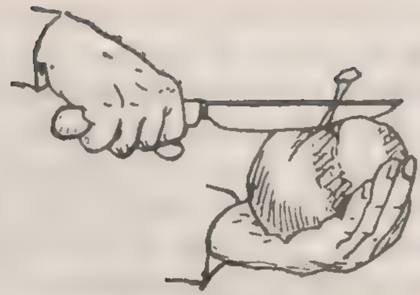


Fig. 5.10

(3) Heavy buses and trucks have double wheels and broad tyres. The area of the road upon which these vehicles rest, therefore, becomes large, reducing thereby the effective pressure on the tyres. Had the wheels been single and with narrow tyres, the pressure due to the thrust of the vehicle would have been large enough to burst them.

(4) Steel plate belts are provided under the wheels of heavy tanks and tractors to increase the effective area, consequently to reduce the effective pressure due to the thrust of the vehicle so that it could conveniently move forward even on rough ground.

Fig. 5.11

(5) Iron rails of the railway track are fixed over large, and wide wooden or steel sleepers to reduce the effective pressure of wheels due to enormous thrust of the train's load, thus preventing them from getting buried into the earth.

(6) While walking over the soft earth, say on the wet bank of a river high heels sink deeply into the earth because of the great pressure exerted due to the thrust of the body. The heels of some one walking bare foot make only a slight impression. The thrust in the later case is being equally distributed.

It is not necessary that the force acts only in the downward direction. As a matter of fact forces do act in all directions and consequently thrust can be effective in all directions. So far we have seen the thrusts due to the weight of the bodies.

Fig. 5.12

A drill moves in the horizontal direction when the carpenter exerts the thrust to bore a hole in the door or window frame.

5.4. Pressure in Fluids

We have so far seen thrust, and pressure and their effects in case of solids only. Thrust and consequently the pressure are exerted by liquids as well as gases. Rather, the effect is more prominent in them and hence needs special study. We shall deal with fluid pressure in the rest of this chapter. First we will take up the liquids.

5.5. Thrust Caused by the Liquids

Almost all of us have had an experience of getting ourselves in and under water in a river, or a swimming tank or even in a bathing tub and have experienced the thrust that the liquid exerts over our body. As we go deep in water this thrust is felt increasingly, hence the thrust is caused by the weight of the water. But there is one peculiar thing which we did not normally experience in solid that the thrust is not downward alone, but presses our body from all directions. We shall now observe and try to study this formally.

Let us first prepare an instrument which will indicate the effect of a thrust. We know that liquids keep their level. As such if we fill in water in a U-tube, its level will be the same in both arms. Clamp such a tube on a stand, against a graduated board and attach a rubber tube to one arm. On the other end of the rubber tube attach a small funnel, the mouth of which is closed by streching a piece of rubber over it. Our thrust detector is now ready. Press the stretched rubber diaphargm with your finger, this thrust on the rubber diaphargm will push the water in the limb of the U-tube and it will rise in the other limb. The difference in the two levels will be the indicator of the thrust. This is likewise the indicator of pressure also on the diaphragm because the area of the diaphragm does not very much ordinarilly. This simple pressure detecting instrument is called the *Manometer.*

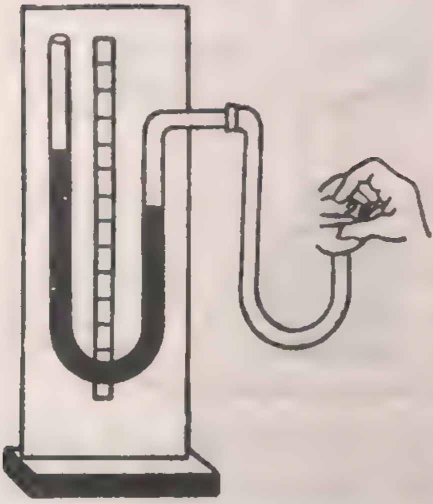


Fig. 5·13 The monometer.

Let us now examine a liquid at rest, say water filled in a vessel. Since the liquid is at rest, forces acting on every particle of it are balanced, irrespective of its position. Hence the pressure at any point in the liquid is the same in all directions.

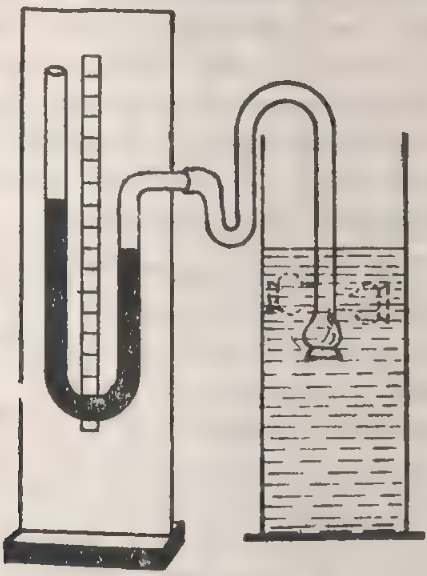


Fig. 5.14

Let us verify it with our manometer. Bring the diaphragm funnel inside water and look at the levels in the two limbs of the manometer. The level in one goes down and rises in the other as the funnel is taken lower and lower ; but if it is held at the same depth and its position or merely direction is changed no effect is indicated on the manometer.

This means (i) Pressure of a liquid increases with its depth ; (ii) At the same depth, the pressure is the same at all points ; (iii) At any point, the liquid pressure is the same in all directions.

Let us perform some more experiments to confirm these findings.

Take an empty tin can and pierce 3 holes of equal bore one above the other vertically, and cover them with cellotape to be opened at will. Now fill the can upto its brim and remove the cellotape to open the holes. Why should the water from the lowest hole go the farthest ?

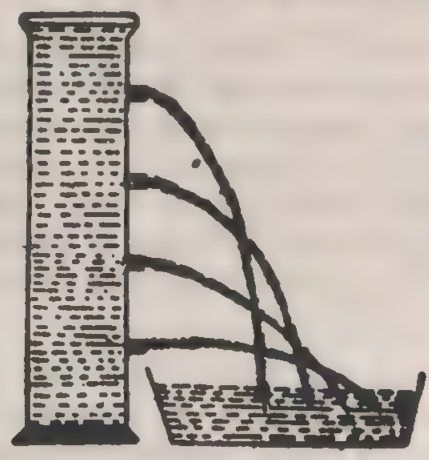


Fig. 5.15. Pressure increases with the depth.

Only because of the largest pressure which exists at the greatest depth and consequently the pressure is the least at the

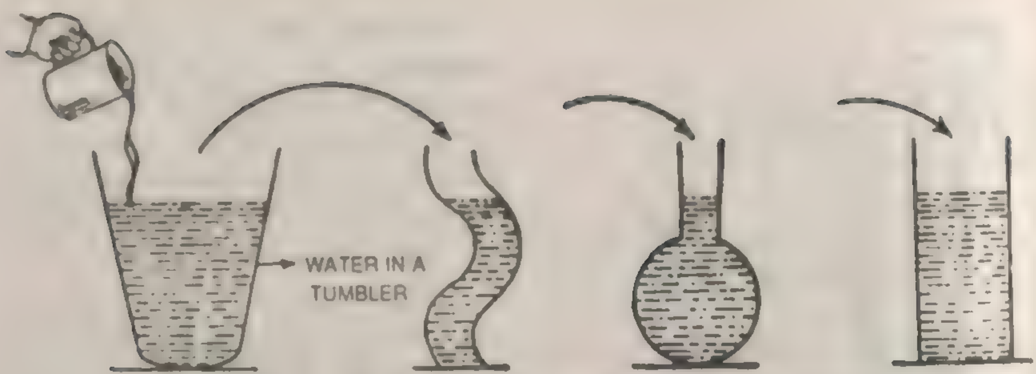


Fig. 5.16. Shape and size of vessel have nothing to do with pressure.

least depth. This confirm our first finding-pressure increases with the depth.

Take another similar can and this time pierce several holes at the same height and repeat the above experiment. Why should the water go to equal distances from all the holes ? Simply because this time the pressure at all points is the same. This confirms our second finding *i.e.*, pressure is the same at all points at the same depth.

It is this pressure and consequently the thrust, that is felt by us when we go into the water of a pond or a swimming tank from all directions. The side-ways pressure is also exerted on the walls of the container and this goes on increasing as we go deeper and deeper into the liquid.

The pressure (p) of a liquid at a certain depth (h) is the product of the depth, its density (d) and the acceleration due to gravity (g).

We may write this as

$$\boxed{p = hdg}$$

The area of the vessel, its shape and size have nothing to do with the pressure of the liquid in it. It only depends on its depth, provided the density remains the same at all depths.

This fact can be verified by taking vessels of different shapes and sizes and measuring the pressure at their bottom when they are filled with the same liquid and up to equal heights. The pressure detector we have already made, could serve the purpose well. Here, we attach separate manometers to the vessels but they indicate the same pressure. In place of manometers we could use the pressure gauge or any other device.

This clearly explains why liquids should stand on the same level if the vessels are joined together at the bases. Because the pressure of the liquid columns will be the same at the bases, there will be no tendency to flow even on joining them. That is the reason why a liquid always seeks its level – the principle on which the city water supply is based. The water reservoir is placed at a level higher than any house. Water reaches the tallest houses in its effort to seek its level.

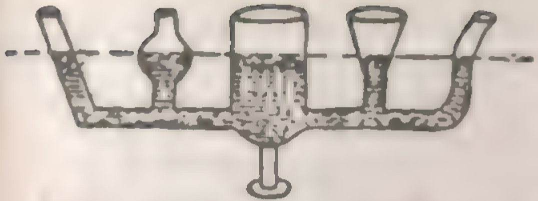


Fig. 5.17. Liquid stands on the same level.

As the pressure of the liquid increases with its depth, it causes an enormous thrust over the deep sea divers. The diver will be crushed under this thrust if he does not put on his diver's suit. This is made of such material as can withstand the enormous pressure of water. When the diver goes deep into the sea, he is supplied air to breathe through tubes connected with the boat from which he dives into the sea.

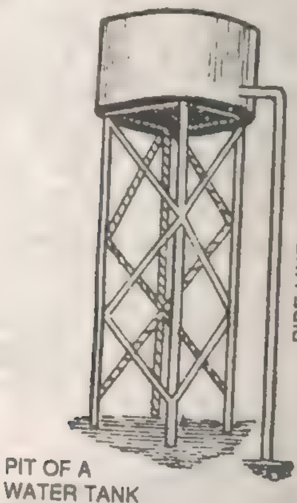


Fig. 5.18. Water reservoir at a high level.

We have so far considered only one factor on which the pressure of the liquid depends, that is depth. Looking into the expression

$$p = h \times d \times g$$

We see that the pressure will change if the density of the liquid changes, *i.e.*, if we have similar vessels and fill these with different liquids upto the same height, the pressure will not be the same at their bottoms as indicated by the manometers.

As the pressure increases with the depth, consequent thrust also increases as we go deeper and deeper ; it is, therefore, obvious that the lower portion of the dam walls is required to withstand larger pessure than the upper one. Hence, it is necessary that the walls should be much wider at the base than at the top.

Fig. 5.19. Section of a dam to show that the walls are wider at the bottom.

5.6. Atmospheric Pressure

We live on the earth and there is a lot of air around us. Air has weight and therefore exerts a pressure on the surface of the earth and on all the objects on the earth, including ourselves. This pressure known as *atmospheric pressure* is due to the weight of air over the surface of the earth.

Take a foot-ball bladder and weigh it on a sensitive physical balance. Now fill up the bladder with air and again weigh it. You will find that the weight of the bladder is increased.

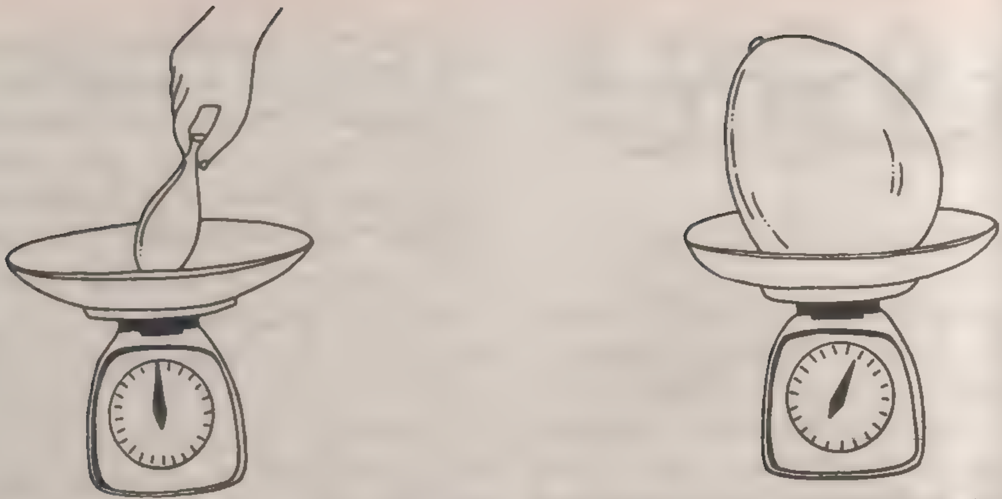


Fig. 5.20. An empty bladder and a bladder filled with air in turn on a pan of physical balance, showing bending of beam in second case.

Fill up a glass tumbler with water right upto the mouth. Cover the mouth by a piece of paper from your exercise book. Now after pressing the paper and keeping the hand on the paper, turn the tumbler upside down. The water does not fall down even after removing the hand from the paper. Why ? the atmospheric pressure acting on the paper vertically upward balances the pressure of water acting vertically downward due to the weight of the water.

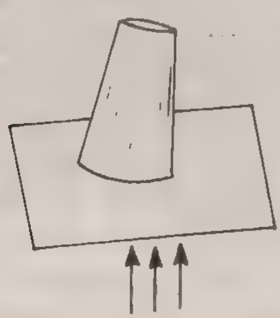


Fig. 5.21

Take a large tin and partially fill it with water. Heat the tin till sufficient steam comes out of the tin. Screw the lid tightly on the mouth of the tin. There is no air left inside the tin, it has been replaced by steam. Now pour cold water from a tap on tin (See Fig. 5.22). The tin collapses inwards due to large force created on it by the outside air. On pouring water on tin, the steam inside gets condensed into water leaving vacuum. So the large force created on tin from outside is left unbalanced and tin gets collapsed.

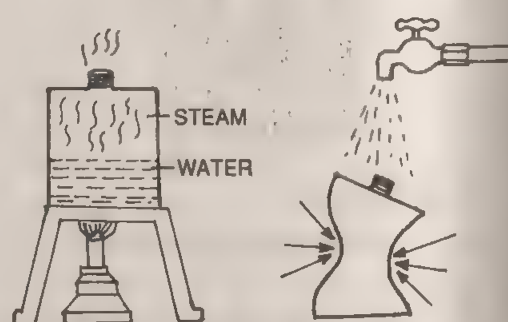


Fig. 5.22

You must have drunk Campa-Cola with the help of straw. It is due to atmospheric pressure on liquid surface of

Campa-Cola that it rises in the straw when you suck air with mouth from straw creating vacuum there.

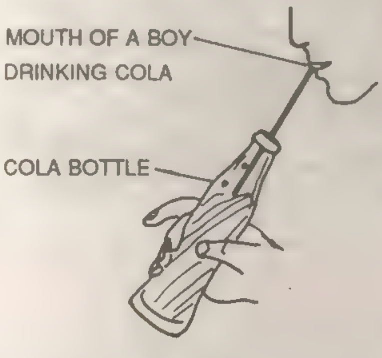


Fig. 5.23

The filling of ink in the fountain pen is also based on the existence of atmospheric pressure. When we press the rubber tube of the pen, the air is pushed out and a vacuum is created in the tube. On removing the pressure from the tube, the atmospheric pressure acting on the surface of the ink in the inkpot pushes the ink into the tube of the pen.

Otto Von Guericke conducted an experiment in the year 1640 in the town of Magdeburg to show the large value of atmospheric pressure. Two tight fitting hollow metallic hemispheries each provided with a hook, were joined together. The air inside the sphere was pumped out creating vacuum inside. As a result the large atmospheric pressure pressed the hemispheres so harder that even the two teams of eight horses pulling it in opposite directions could not separate them.

Though the pressure exerted by air on us is very large (76 cm of mercury or $1.013 \times 10^5 N/m^2$) we do not feel it because our blood itself exerts almost the same pressure and the two pressures balance each other. So we do not feel any discomfort.

Measurement of Atmospheric Pressure

The instrument used for measuring the atmospheric pressure is known as *barometer*. The simple mercury barometer was devised by Torricelli.

Take a 1 metre long glass tube open at one end and closed at the other. Fill it up with mercury. Invert this tube closing its open end with finger in a cistern filled with mercury. Remove the finger

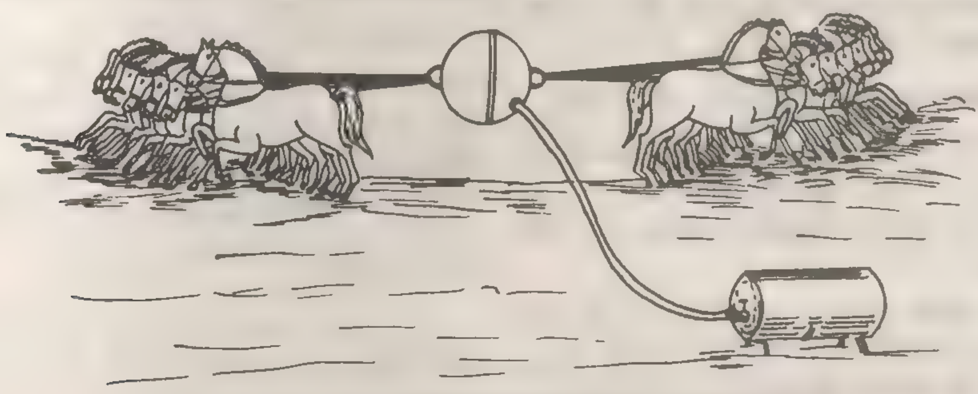


Fig. 5.24. The effect of atmospheric pressure is not overcome even by the efforts of eight pairs of horses.

from open end of the tube when this end is well inside the mercury in cistern. Some of the mercury from tube falls down in cistern and the rest stand at a constant height of about 76 cm due to the atmospheric pressure acting on the free surface of mercury in cistern. There is no air in space above the mercury column in tube and the space is known as Torricellian vacuum.

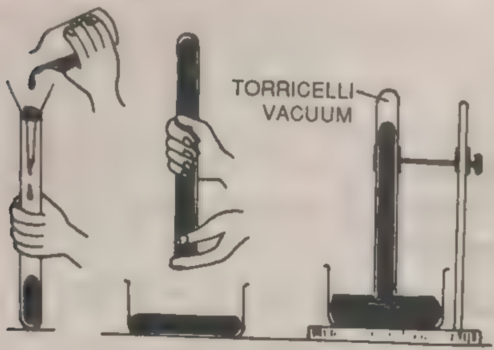


Fig. 5.25.

The barometer used in practice to measure atmospheric pressure are Fortin's barometer and Aneroid barometer etc.

It is the atmospheric pressure that makes all types of pumps like air pump, water pump, football pump, cycle pump, lift pump, vacuum pump, force pump, perol pump, pipette, syringe, siphon and automatic flush system etc. to work.

5.7. Buoyancy (Archimedes Principle)

It is the experience of the sailors at sea that it becomes difficult to lift the heavy anchor of the boat when it is out of water.

Similar is the experience of the boatmen when they row the boat. Oars are left heavy when they are out of water.

Fig. 5.26. Oars are felt heavier when out of water.

We can also recall that the *lota* becomes heavy when it is taken out of the bucket full of water. Why are the objects felt to be heavier when they are out of water than when inside it ?

More than 2,000 years ago, an old philosopher in Greece was also confronted with similar experience. One day, he entered the bathing tub full of water. He noticed that as soon as he entered the tub, a lot of water was spilled out and he felt his body to be much lighter. This made the old philosopher think. Why should the water flow out ? Why should he feel lighter ? Is there any relation between the two ?

He persued this chain of thought and conducted some experiments which we will repeat here for our-selves and see if the two phenomena of over-flowing of water and feeling of lightness are related.

Activity 5.1

To find the amount of water displaced by a body when immersed in water :

Take an *Over-Flow* or *Eureka* vessel and fill it with water. Place a previously weighed beaker under the side tube. Take the object (say, a glass stopper), tie it to a thread and lower it into the overflow vessel. Note what happens ? The water displaced by the object over-flows into the beaker. Weigh the beaker to find the weight of the water displaced by the object.

What relation does the volume of water displaced have to the volume of the object ? They are equal.

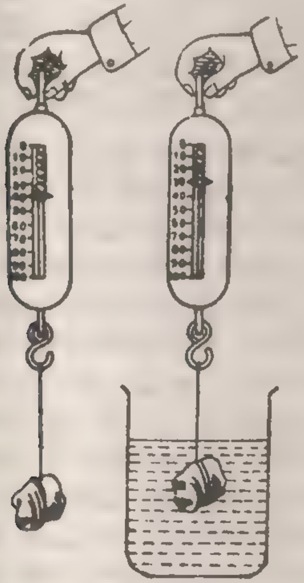


Fig. 5.27

Now, repeat the experiment, but, this time suspend the object from a spring balance. Note and record its weight. Lower it into the over-flow vessel keeping your eyes on the indicator of the balance. Note that it moves up, thereby showing a decrease in weight. When the object is completely submerged and suspended in water, note its weight again. See that it does not touch the vessel anywhere. Find how much the object loses in weight when submerged in water. Compare the loss in weight to the weight of the water displaced by the object. You will find that the two are equal.

Repeat the experiment again, this time placing the beaker on one spring balance and suspending the object from another.

Now let us immerse this object into the water of the over-flow vessel, and note the difference in the two balance. It will be found that the spring balance registers a decrease in the weight of the solid which is exactly the same as the increase in weight of the beaker due to the water collected in it, as shown by the balance on which it is placed.

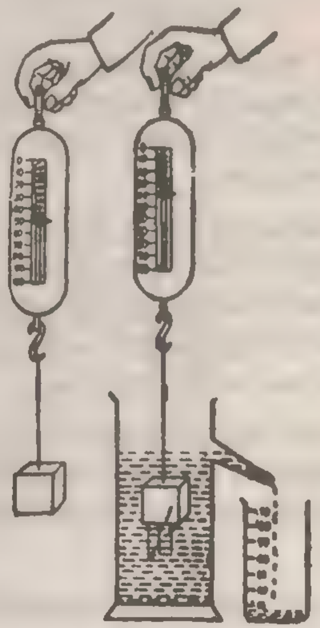


Fig. 5.28. Weight of water displaced is equal to loss in weight of the body.

Now let us analyse the situation. Water over-flowed from the vessel be-

cause the solid needed the space inside and hence displaced it. Naturally, the displaced water is of equal volume to the solid itself. The weight of the solid was decreased because the water exerted *upward force* called *buoyancy* on it, as we have already learnt it does. And hence, the resultant downward force, *i.e.*, the decrease in weight is equal to the upthrust.

The weight of water collected in the beaker is observed to be equal to the decrease in the weight of the solid. This shows that the upthrust is equal to the weight of the water displaced.

If you go on repeating these experiments using different objects and weighing them in different liquids you will find that :

1. If solids of different materials which are equal in volume are taken, the loss in weight in the same liquid is always the same.

2. The loss in weight of a solid, double in volume, is double, irrespective of the material of the solid, *i.e.*, the loss in weight 'depends directly on the volume of the solid and not on its material.

3. The loss in weight of the same solid changes in different liquids *i.e.*, the loss in weight depends on the density of the liquid.

We can, therefore, generalise our observations, as the philosopher Archimedes did :

When a solid is immersed in a liquid, it apparently experiences a loss in its weight. This loss in weight is equal to the weight of the liquid displaced by the solid.

This is known as the **Principle of Archimedes.**

It will be interesting to know that Archimedes discovered this principle accidentally which he was given a serious problem to investigate. The king had given some pure gold to a goldsmith for his crown. But, when the crown was ready, the king suspected that the goldsmith had cheated him, although the weight of the crown was exactly the same as that of the gold given to him. He ordered the philosopher to investigate into the purity of the material of the crown.

You know how during his bath he suddenly realised what he ought to do. He reasoned that the crown would displace its own volume of water and so would the piece of pure gold of the same weight. But the weight of water displaced, hence the loss in weight will only be equal if the material of crown was exactly the same as that of the piece of pure gold. And he actually weighed them in air and water and found that the loss in weight in case of the crown was more than that in the case of pure gold. Hence he concluded that the crwon was less dense, *i.e.*, it was made of a mixture of metals lighter than gold. Silver or copper might have been mixed in gold to make up the original weight.

If we immerse a cork under water and release it, it rises and floats on the surface. Similarly, if we release a balloon filled with hydrogen, it rises in the air.

When we draw water from a well, we find it easy to pull the bucket when it is inside the water. But as soon as it comes out of the water it suddenly appears to have become heavier.

All these phenomena are due to a property of liquids and gases, called *buoyancy.*

Whenever an object is partly or completely immersed in a fluid (liquid or gas), it experiences an upward force. This upward force is called the **buoyant force.**

Animals like whales which live in water grow to an enormous size. The buoyant force of water helps them to move easily. With such enormous size, it would have been difficult to move on land. The fishes use the buoyants force of water to come upto the surface of water. They have a special organ within their body called the *air bladder.* For coming up, the fish swells the bladder and for going down it withdraws the gas. Submarines, which run in the depths of the ocean, are also designed on the principle of thrust and buoyant force. The same is true about the dresses of the divers who dive deep down into the ocean and can stay there for a certian period of time and then come up.

How can we measure the buoyant force ?

Let us take a solid body and hang it from a spring balance [Fig. 5.29 (a)]. The

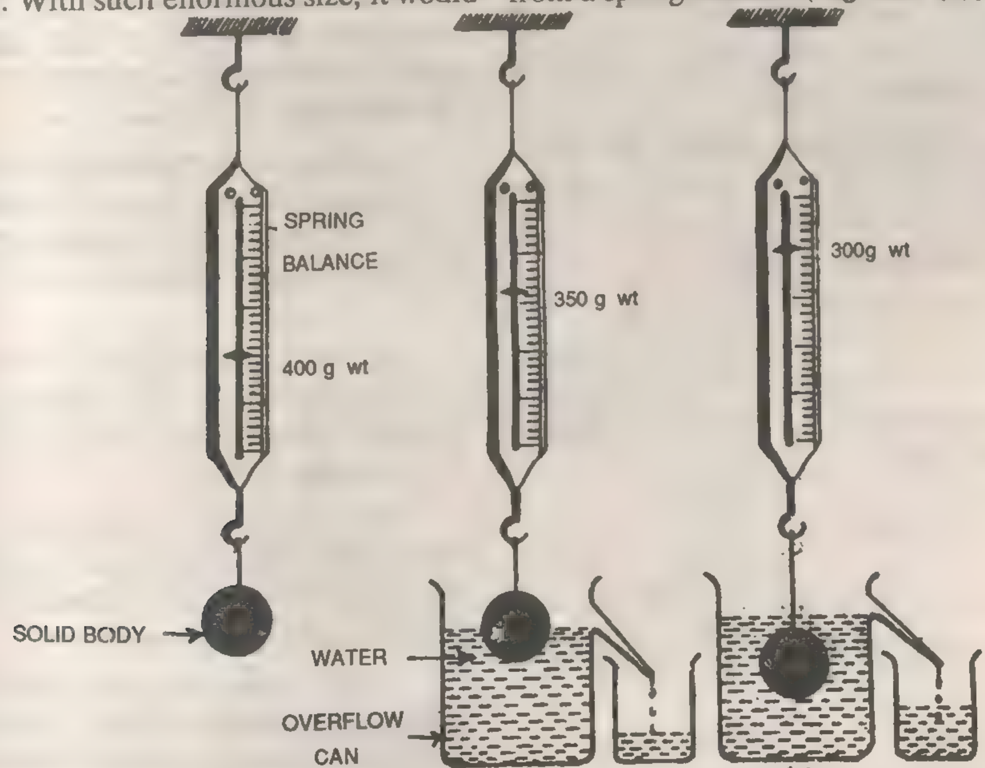


Fig. 5.29 Measuring the buoyant force

reading on the balance shows its weight. Suppose it is 400 gm wt. Now dip a part of the solid body in an overflow can containing water [Fig. 5.29(b)]. Suppose the spring balance now reads 350 gm wt. This means that buoyant force is 400−350 = 50 gm wt.

Let us dip the solid body completely and suppose the reading is 300 gm wt. [Fig. 5.29 (c)]. This means that the buoyant force when the solid body is completely immersed is 400 − 300 = 100 gm wt. You will find that dipping the solid body any further does not change the reading on the spring balance. This means that the maximum buoyant force equals 100 gm wt.

In the above experiment, if we measure the weight of the water which overflows from the overflow can, we find an interesting result.

In each case, the buoyant force equals the weight of the water collected. It proves Archimede's principle.

5.8. Floatation of Bodies

Take a steel spoon and a steel bowl. Put them gently on the free surface of water in a vessel. What do you find ? The spoon sinks down and bowl floats on water. Why ?

Fig. 5.30

Take a cork. Immerse it into water well upto bottom. You will find cork will move up and finally floats on water. Why ?

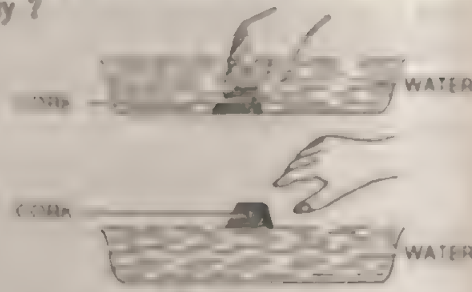


Fig. 5.31

When a body is immersed in a liquid, it is acted upon by two forces :

(1) The weight of the body acting vertically downwards, and

(2) The buoyant force acting vertically upwards. Now there are three possibilities :

1. The weight of the body is more than the buoyant force ; the body will sink. For example, the steel spoon in the above activity sank down.

2. The weight of the body is less than the buoyant force ; the body rises and more and more of its portion emerges out. For example the cork is rising in the above activity.

3. The weight of the body is equal to the buoyant force ; the body floats. For example the steel bowl is floating on water in the above activity.

So the principle of floatation is that the weight of the body should be equal to the weight of the liquid displaced by its immersed portion (buoyant force).

That is why a piece of cork immersed deep into water rises when left free. It rises till the weight of water displaced by cork becomes equal to the weight of the cork and then floats.

A solid piece of iron sinks in water, but an iron ship floats. This is because the ship is hollow at bottom and has a concave shape. It is capable of displacing so much volume of water that its weight is equal to the weight of the ship and its contents.

A submarine can be made to float or sink in water by controlling the buoyant force. When it is required to dive the water is admitted into the tanks in the bottom of the submarine when it is required to rise it to surface, the water is ejected out of the tanks.

By learning the art of swimming, one can swim on water. It is much easier to swim in sea water than in river water. The reason is the density of sea water is greater than that of river water and hence the buoyant force experienced by swimmer in sea water is comparatively larger.

Big pieces of ice float on sea water, with only a small portion exposes. They are, therefore, great hazards for navigation.

5.9. Pascal's Law

It is an interesting sight to see a heavy car being lifted over a column coming up from the ground in an automobile workshop. This is done for the purpose of cleaning or repairing the machine at the bottom of the car. The weight of the car is so heavy that it cannot easily be lifted even by as many as six persons and that too to such a great height. It is quite amazing to learn that this is lifted here by a piston dipped in an oil tank on which a comparatively much smaller force is applied through a narrow pipe. How does this oil develop such a large force ?

To study this we shall have to revise our knowledge of the liquid pressure again. We have seen that if different containers are joined together at their bases and a liquid is filled into each one of them, the level of the liquid stands at

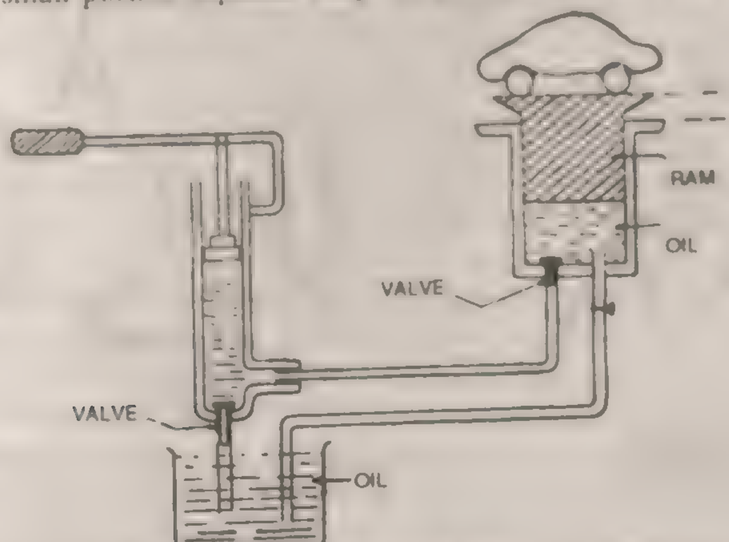


Fig. 5.32. A heavy car being lifted over a column.

the same height in all of them irrespective of their upper shapes or sizes. We have also measured the pressures at the bases of the three vessels separately and found that they are equal. That is the reason, we had assigned, that the liquids do not flow from a larger vessel to the smaller vessel. How does then the extra thrust, due to weight of the liquid in the wider vessel act ?

To answer this, let us perform a simple experiment. take a rubber ball and pierce into it a number of small holes by means of a needle at different places. Squeeze the ball inside water and release so that air comes out and water gets filled into it.

Take out the ball and again squeeze it at any point and observe the water jets coming out of the holes we had pierced. It is observed that water comes out with equal intensity from each hole and falls down at equal distances from the ball in all directions.

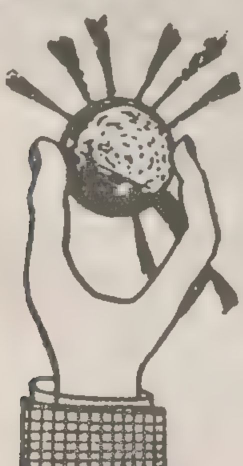


Fig. 5.33. Water comes out from the holes with equal intensity

Has the pressure been equally-transmitted to all points ? It appears so because of the equal intensities of the jets coming out at different points. We can measure their pressures as well. Instead of a rubber ball, this time a glass spherical vessel which has several manometers attached at different points is taken. Water is filled inside the vessel. A pressure is applied to it by a piston at one point. It is observed that water in all the manometers rises equally. It shows that whatever pressure is applied at one point on the water in an enclosed vessel, it is equally transmitted in all directions. water would come out where it gets the way, and at other places the pressure simply exerts thrust at the walls of the vessel.

This also explains our problem of vessels of different sizes and shapes. Thrust due to the pressure at all points has been borne by the walls of the vessel which are strong enough to withstand it.

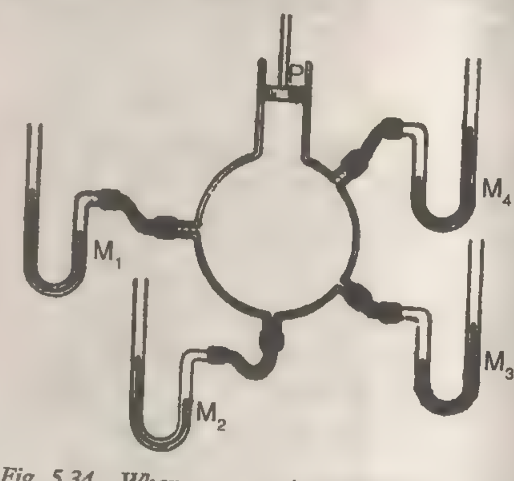


Fig. 5.34. When pressure is applied on the piston, water in all the manometers rises equally

Let us perform an interesting experiment. Take two exactly similar flasks with

just fitting rubber corks. Fill one of them with water upto the brim and cork it. The other may simply be closed by the cork. Place both of them on a rubber cushion. Give gentle blows of hammer to the cork of the one which did not have water. It is observed that the impact of the hammer pushes the cork forward into the flask and the flask does not break with this much of external impact.

Now give a similar blow to the cork of the flask containing water. With just one or two blows the flask cracks. Why do the walls shatter ? In the first case the pressure pushed the cork in because the air could be compressed. In the latter case water could not be compressed, instead it transmitted the pressure of the blows equally to all the points of the walls, thus developing a thrust multiplied many times in magnitude, causing the walls to shatter.

This fact was discovered for the first time by a scientist, *Blaise Pascal.* Hence this principle is called *Pascal's Law.*

When any part of a confined liquid is subjected to a pressure, the pressure is transmitted equally and undiminished to every position of the inner surface of the containing vessel.

If two or more vessels are connected together, they consitute one single vessel for this purpose as the pressure is transmitted equally at all points, including the linking passage as well.

As such, if one vassel has an area of cross section ten times that of the other, the pressure applied at the surface of the liquid in the narrow tube is equally transmitted to the liquid of the wider tube. Thrust at the surface of the wider tube will thus be in magnitude ten times.

This also explains how a heavy car can be lifted by applying comparatively smaller force on the piston of smaller area. Such lifts are called *hydraulic lifts.* Initial force is applied by compressed air at the narrow pipe and as the area of the piston on which the ram is attached is several hundred times larger, the thrust is developed several hundred times, large enough to lift the vehicle. The liquid generally used is an oil which does not freeze during winter.

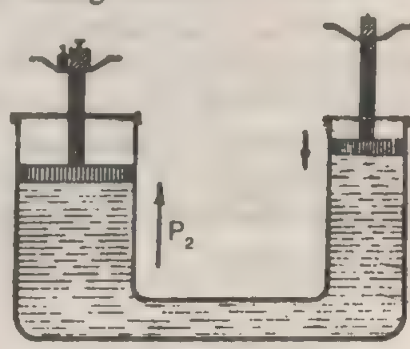


Fig. 5.35

This enormous force, developed due to the large thrust is utilised for different purposes.

1. **Hydraulic Press.** Cotton or other stuff is compressed to be tied into bales of much smaller volume by means of a press working exactly on the same principle. The ram is attached with a platform on which the cotton is heapped. It is pushed against the steel roof over-head with the enormous thrust. This press is also called the *Bramah's Press.*

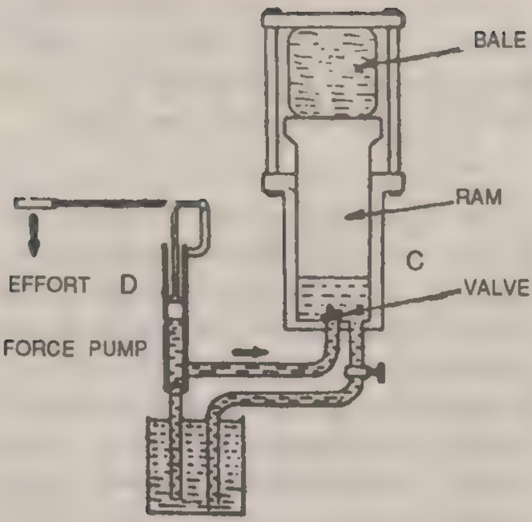


Fig. 5.36. The Bramah's Press.

2. **The Hydraulic Brakes.** As the pressure is transmitted uniformely and simultaneously at all the points and in all directions by this device it is also utilised in the brakes of the automobilies, which simultaneously grip all the four wheels uniformally and with the same force when the lever is pushed by the foot of the driver. (5.37)

3. Since heavy uniform thrust is developed, this device is also used in crushing of oil seeds and in pressing stout metal sheets to desired shapes. The body of the automobilie, cars or scooters is pressed into definite shape out of the stout steel sheets under the hydraulic press.

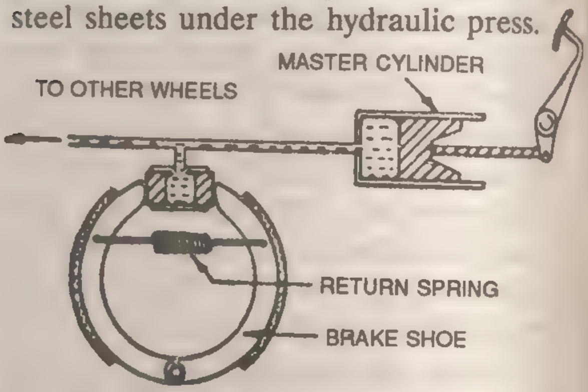


Fig. 5.37. Hydraulic brakes being applied by the driver.

4. Pascal's Law is utilised in simultaneous lifting and lowering of the wheels of the aeroplanes, when it takes off or lands. The pressure on the same liquid also moves its wings and fans, by a little manipulation of levers by the pilot.

5. In large buildings where there are thousands of windows and ventilators, it would be very difficult to open them manually and it will take a long time to do so. By connecting the levers attached to all of them, to a pipe-line in which oil is filled pressure applied at one end can be made to open or close all of them simultaneously. This is how it is done in large buildings in western countries.

SUMMARY

1. Force is a push or pull which changes or tries to change the position of a rigid body.
2. Force is a vector quantity and has magnitude as well as direction.
3. Force is represented graphically by a vector (straight line) whose length is in proportion of the magnitude of the force and which has an arrow on one end pointing in the direction of force.
4. Forces are of several kinds such as gravitational force, frictional force, magnetic force, electrical force etc.
5. Force = mass × acceleration

6. Weight is the pull of the earth on a body. It is measured in Newtons or Kg/gram-weight.

7. Frictional force is a force which resists the motion of a body moving over another body and acting in a direction opposite to the direction of motion of the body.

8. Total force acting on a body is called *Thrust.*

9. Force acting over a unit area is called *Pressure.* It is measured in Newton per square metre.

10. Pressure of a liquid increases with its depth ; at the same depth, the presssure is the same at all point ; at any point the liquid pressure is the same in all directions.

11. The atmospheric pressure is due to the weight of air on the surface of the earth.

12. The atmospheric pressure is measured by an instrument called barometer. There are many types of barometer.

13. Whenever a solid is immersed in a liquid, it experiences an upward thrust which is equal to the weight of the liquid displaced by the solid (Archimede's principle).

14. If the weight of the body is equal to the buoyant force, the body floats.

15. When any part of a confined liquid is subjected to a pressure, the pressure is transmitted equally and undiminished in every position of the inner surface of the containing vessel (Pascal's Law).

16. We use a number of machines in our daily life which works on this principle.

QUESTIONS

1. Define force.

2. What are its units ?

3. Is force a Scaler quantity or Vector quantity ?

4. How do you represent the force graphically ?

5. If a body of mass 2 Kg is moving with an acceleration of 5 ms^{-2}, what is the force acting on the body ?

6. If a force of 4 Kg wt is acting on a body of mass 2.5 Kg, what is the acceleration produced in the body ?

7. When a force of 12 N acts on a body, the accleration produced in the body is 3 ms^{-2}. Calculate the mass of the body.

8. What is the weight of a body in Newton if its mass is 6 Kg.

9. Why a body weighs less at the moon than at the earth ?

10. A bus, when pushed by one boy does not move. Does it mean he is not applying force ?

11. State whether the following quantities are Vector or Scaler ?

Force, Mass, Length, Temperature, Weight, Volume, Density, Pressure.

12. Define (i) Thrust (ii) Pressure (iii) Force of Buoyancy.

Give one example for each case.

13. State (i) Archimede's principle ?
 (ii) Pascal's law.
 (iii) Principle of floatation.
Give one example of the each case.

14. Distinguish between :
 (i) Mass and Weight
 (ii) Thrust and Pressure
 (iii) Weight and Buoyant force

15. Mention the units of
 (i) Mass (ii) Weight (iii) Force
 (iv) Thrust (v) Pressure

16. (i) Pressure is .... per unit area.
 (ii) A body floats on a liquid when weight of body is equal to .... force.
 (iii) .... is the unit of mass.
 (iv) .... is the unit of weight.
 (v) .... is the unit of density.
 (vi) The density of a substance is independent of its .... or ....
 (vii) .... is an instrument to measure atmospheric pressure.

17. (i) Why do we not feel such a large atmospheric pressures on our body ?
 (ii) Why our nose bleed, at a high altitude ?

18. Describe a simple barometer.

19. Match the statements in Column A with those in Column B.

Column A	Column B
(a) Barometer	(a) are two different physical quantities.
(b) A body floats in a liquid	(b) is the pull of earth on the body.
(c) Mass and weight	(c) cars, electric motors and cycles.
(d) Ball bearings and Roller bearings are used in	(d) If weight of body is equal to buoyant force.
(e) gravity	(e) is an instrument which measures the atmospheric pressure.

20. Arrange the following substances in order of their densities, starting from the highest value :

Copper, glass, water, milk, ice, alcohol, lead, cork, gold, common salt.

21. Fill in the blanks :

(i) Thrust is ....

(ii) A .... liquid offers greater buoyancy than a .... one.

(iii) All bodies appear ...... when they are immersed in a liquid.

(iv) Liquids and gases exert pressure in ....

(v) .... is equal to the force acting on unit area.

(vi) The .....of water in the sea helps whales to move easily.

22. What is the principle of floatation ?

23. Why it is easier to swim in sea water than that in river water ?

24. A piece of iron sinks down in water. How is it then that heavy ships of irons float on water ?

ACTIVITY

1. When we put 3 bricks of same weight and size on sand in different ways. They sink in sand by different amount. How will you explain it ?

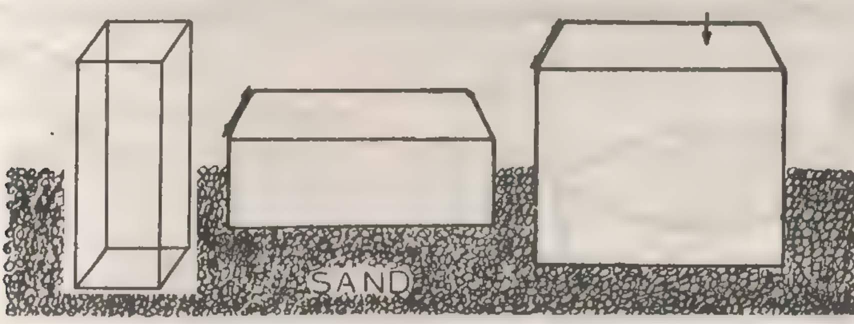


Fig. 5.38. Some brick is acting different pressure when placed in different ways.

Do this activity yourself and enjoy.

2. Take a tumbler full of water. Cover it completely with a piece of paper. Invert the tumbler. Water does not fall down. Why ?

CHAPTER 6

LIGHT AND OPTICAL INSTRUMENTS

6.1 Refraction of Light

If you put a pencil in a glass of water and look down along the pencil into the water, the pencil seems to bend at the water line (Fig. 6.1). Since we know that the pencil is not bent, the only explanation we can give is that the light rays are bent. This type of bending of rays of light is known as *refraction of light.*

We come across many examples of refraction in our daily life.

A coin at the bottom of a cup filled with water, appears to be raised up (Fig. 6.1).

The bottom of a lake or a swimming pool, filled with water, appears shallower.

In the same way, a boy standing up in a river presents a strange sight to a person looking at him from the bank. The part of the body under water appears deformed and much shorter than it actually is.

All this has been explained on the basis that *whenever a ray of light passes from one type of transparent substance into another of different optical density, it is bent off its original direction and is known as refraction.*

Different media are said to have different optical densities. Those in which the *velocity of light is less than in vacuum are said to be optically denser.*

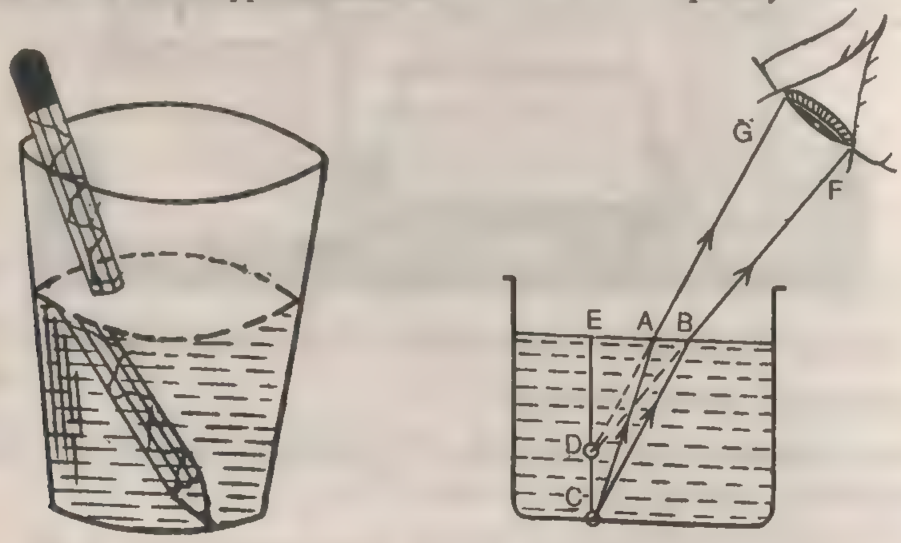


Fig. 6.1 Light rays change velocity when they pass from one medium to another.

When a ray of light passes from an optically rarer to an optically denser medium, the ray bends towards the normal.

But, if the ray travelling through an optically denser medium enters a rarer medium, it bends away from the normal.

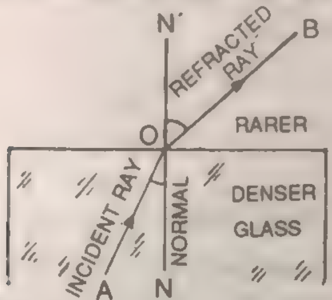


Fig. 6.2 Refraction of light

Let AO (Fig. 6.2) be the incident ray at O on the surface dividing two media, air and water. Let NN be the normal to this surface at O. Let OB be the refracted ray. Then AON is the *angle of incidence* and BON is the *angle of refraction*. As the ray has entered a rarer medium, the angle of refraction is greater than the angle of incidence.

6.2 Refraction of Light through a rectangular piece of glass or plastic

Activity 6.1

Let AB be a ray of light incident on the plane surface of the slab at B (Fig. 6.3). The ray bends towards the normal as it enters into an optically denser medium. At C, the ray emerges from the glass into air and deflects away from the normal in the direction CD. Thus, after passing through the slab, the ray remains parallel to its initial direction but is slightly displaced laterally.

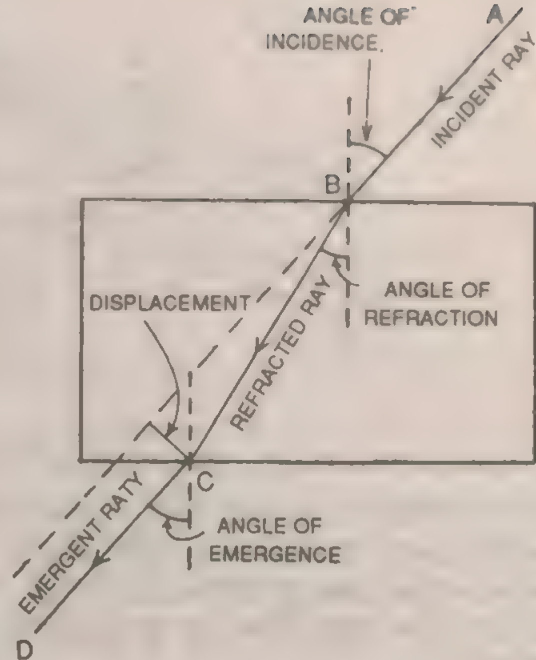


Fig. 6.3 Refraction of light through a glass slab

For a given angle of incidence, the lateral displacement depends upon the thickness of the slab and the optical density of the material. It increases with the thickness and also with the increase in optical density.

6.3 Refraction through a Prism

Let us now study the propagation of a ray through a prism.

Activity 6.2

Draw the outline of a prism on a sheet of paper pinned to a drawing board (Fig. 6.4). Draw a line OP making an angle with one face and place two pins A and B on this line. Put the prism back in its outline and sighting through it, place two more pins C and D in line with A

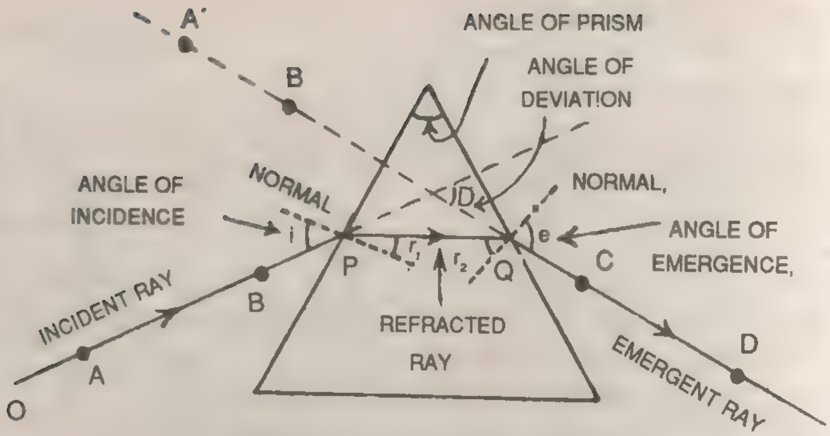


Fig. 6.4 A ray of light passing through a prism

and B. Join the position of the pins C and D extend the line till it touches the outline of the prism at Q. Join PQ. OPQD indicates the path of the ray through the prism.

It is clear that the ray of light, while passing through the prism, is bent twice towards the base of the prism. When viewed through the prism, the pins A and B appear at A and B and are apprecia-bly displaced.

As the ray of light enters from air to glass, it bends towards the normal, that is, the angle of refraction r_1 is less than the angle of incidence (i). This refracted ray is then incident on the other face of the prism. Here, it enters from glass to air and hence bends away from the normal. This means that the angle of emergence (e) is more than the angle of incidence (r_2) on the other face. Thus, after two refractions, emergent ray has an overall deviation towards the base of the prism. The angle between the incident ray and the emergent ray is called the *angle of Deviation (D)*. The greater the angle of the prism, the greater is the angle of Deviation.

6.4 Dispersion of Light

In 1666, Sir Issac Newton observed that a beam of white light, after passing through a prism, emerged as a beam of multi-coloured light. If it is allowed to fall on a screen, a band of seven colours **Violet, Indigo, Blue, Green, Yellow, Orange** and **Red** *(VIBGYOR)* is obtained on the screen (Fig. 6.5). This band of seven colour is called a *spectrum* and the phenomenon of splitting of white light into seven colours is called *Dispersion*.

This dispersion occurs because the different colours are refracted through different angles by the prism. Red is deviated the least, while violet is deviated the most.

Two probabilities confronted Newton--(*i*) either the prism somehow gave these colours to white sunlight or (*ii*) these colours were already present in the white

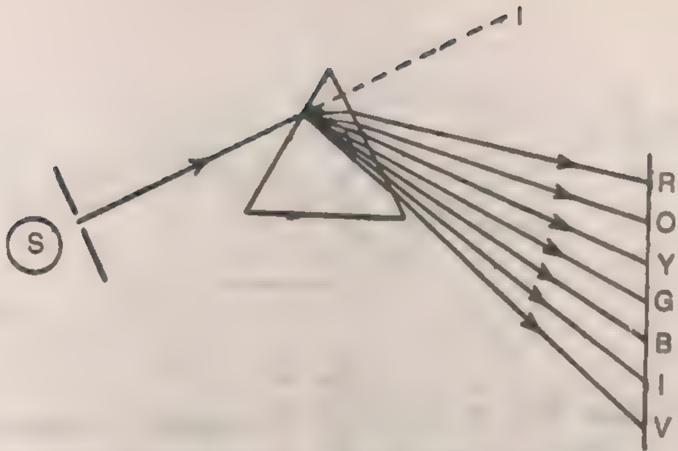


Fig. 6.5 Dispersion of white light through a prism

light and they were merely separated on passing through the prism. Newton performed the following experiments to know the fact.

Newton obtained the spectrum on a card board screen (Fig. 6.6). A narrow horizontal slit was cut in it at the place where the spectrum was formed. He arranged the slit so that it only allowed one colour of light to pass through the slit. The rays of a particular colour passing through the slit were again allowed to fall on a second prism and the emerging light was received on a screen S. The ray did not change its colour. A green ray coming through the card board slit remained green on passing through the second prism. It proves that the prism has no ability to produce new colours.

In another experiment, the dispersed beam of light coming through the first prism was allowed to fall on another prism exactly similar to the first (Fig. 6.7). The two prisms were placed with their faces parallel but their refracting edges in opposite directions. Thus, the second prism produced a deviation which was exactly equal and opposite to that produced by the first. As a result a spot of white light was obtained on the screen. This shows that the seven colours after passing through the Second prism recombined to give white light.

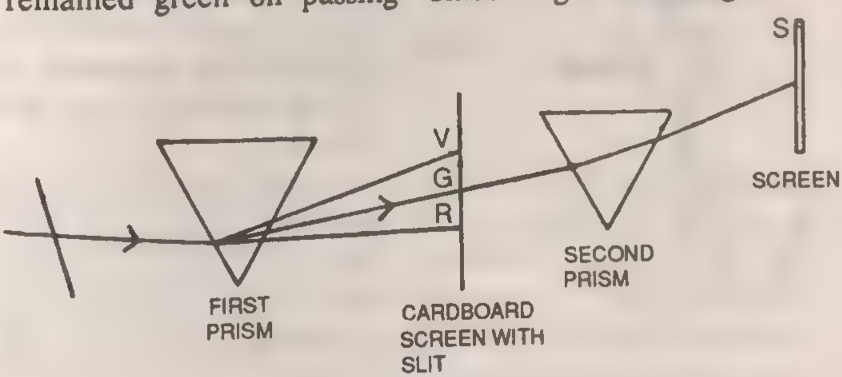


Fig. 6.6

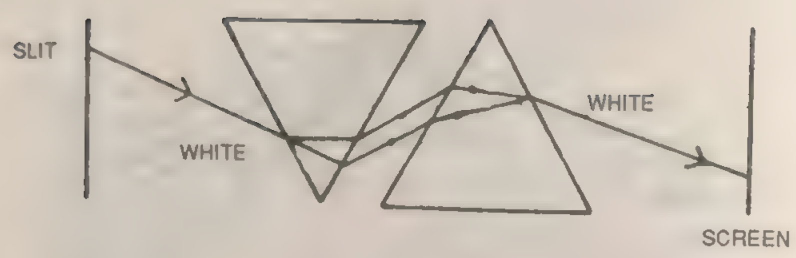


Fig. 6.7

Newton's Colour Disc It is a very simple device to show that the light is composed of seven colours. It consists of a circular disc of thin metal sheet on which sectors of spectrum colours are painted in the same order in which they appear in the spectrum (Fig. 6.8). This disc is mounted on a horizontal axle and is rotated rapidly. It is found that on rapidly rotating the disc, it appears white to the observer. The reason is very simple.

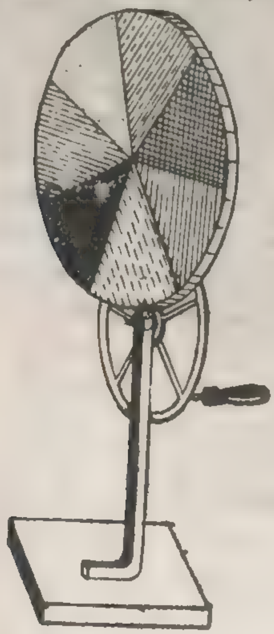


Fig. 6.8

The images of different colours fall on the retina in quick succession. Due to the persistence of vision the different colours are mixed on the retina and, therefore, the disc appears white.

These experiments prove beyond doubt that the light is composed of seven colours and when white light passed through a prism each colour bends to a different extent. Thus, the different colours are separated and a spectrum is obtained.

6.5 Mixture of Colours

You can discover that by mixing **red, green** and **blue** colours, white light can be produced. The other colours of the sun's spectrum can also be obtained by mixing two colours out of red, green and blue in proper proportions. These three colours are, therefore, known as **basic** or **primary** or **fundamental** colours. None of these can be produced by mixing other colours.

When red and green colours are mixed, we get *yellow* colour, and when yellow colour is mixed with blue colour, white light is obtained. Similarly the combination of red and blue produces

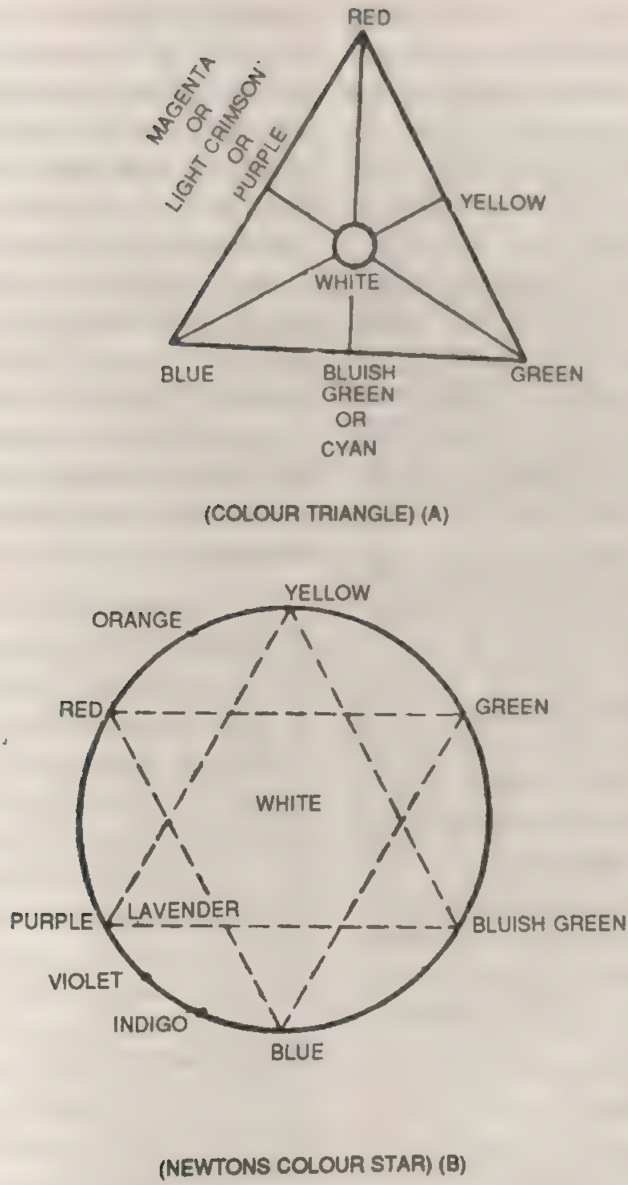


Fig. 6.9

Purple or light *crimson* or *magents* which when mixed with green colour produces white colour. The combination of green and blue colour produces *blue-green* or *cyan* which when mixed with red colour produces white colour. Pink Lavender, etc., are mixtures of white and other colours. The new colours so formed (yellow, purple, blue-green etc.) are called **Secondary colours.** To remember the primary colours and their secondary colours, we draw the *colour triangle* or *Newton's Colour Star* as shown in Fig. 6.9.

The primary colours red, blue and green are placed at the three vertices and three secondary colours formed by the addition of any two primary colours are shown on the middle points of the three sides of the triangles. White is written in the middle of the triangle and it is formed either by mixing all three primary colours or by mixing any of the primary colours placed at one corner of the triangle and the secondary colour at the middle point of the opposite side, *e.g.*, red and bluish green; green and light crimson or purple ; and blue and yellow produce white.

Two colours which on mixing produce white are known as *complèmentary* colours. So blue and yellow, green and light crimson or purple and red and blue-green are complementary colours. On the colour triangle, the colours placed at one corner and that on the middle point of the opposite side are complementary. With the help of colour triangle or colour star we can say which two lights or colour should be mixed to produce the required light or shade. There may be thousands of colour shades which are present in different colours.

6.6 Colour of Bodies

Bodies (opaque or transparent) do not have any colour of their own. The colour of the body depends on the *nature* of the incident light and the *selective reflection* or *transmission* of the different colours by the body.

(a) Colour of Opaque Objects :

When light is incident on an opaque body, part of it is absorbed and part is reflected. The colour of the opaque body depends on the nature of the incident light and also on the light absorbed by it. The colour of the body will be the colour of the reflected light. A red flower appears red in white light, because white light has all the colours and when it falls on the red flower, the flower absorbs the rest of the colours and reflects only the red colour. A white body will appear white because it reflects all the colours and does not absorb any. A body appears black in white light because it absorbs all the light falling on it and does not reflect any colour.

If the red body is seen in any other light except white or red it will appear dark, as when these colours fall on it, all of them are absorbed and none is reflected, as it can reflect only the red colour. A white body will appear white in white light; green in green light and blue in blue light and so on. Because, in green light white body will reflect the green colours so it will appear green, in blue light it will reflect blue light and so it will appear blue and so on. Can you say now why blood is red when seen in sun light ? This property of the body to reflect a particular colour is known as *selective reflection.*

If the substance is in the form of a very fine powder, practically no absorption takes place and the powder would appear *white.*

(b) Colour of Transparent Bodies

The transparent solids or liquids held in the path of light owe their colour to

the constituents of white light transmitted by it to the eyes. A blue glass appears blue because it absorbs all the colours except blue which it transmits. A blue glass will appear dark in red or green colour because in case of these lights all the colours will be absorbed and none of them will be transmitted. If a transparent body does not absorb any colour but transmits all the colours equally, it appears to be colourless. This property of the body to transmit a particular colour and absorb the others is known as *selective transmission*.

(c) Colour of Pigments or Paints and their mixtures

The resultant colour obtained by mixing the paints or pigments of two colours is different from the colour obtained by mixing two coloured lights of the same set of colours as that of the paints. For example, when lights of yellow and blue colour are mixed, white light is obtained but when yellow and blue paints are mixed, the resultant paint has *green* colour instead of white. The reason for this is that paints do not possess pure colours and they reflect other colours in addition to their own. The yellow paint reflects mainly yellow colour and a little of the adjacent green and orange colours are also reflected. Similarly, the blue paint reflects mainly blue colour and a little of the adjacent green and indigo colours are also reflected. So, when yellow and green paints are mixed, the mixture reflects the common green colour, as all other colours are mutually absorbed. Hence the mixture appears green. So the resultant colour of the mixture of two paints is the one that has not be absorbed by either of them.

6.7 Light and Human Eye

Whenever the temperature of a body is steadily raised, the colour of the light emitted by it changes. For example, when a blackened platinum wire is raised in temperature by electrical heating, it begins to appear *dull-red* at about 525°C, changes to *cherry-red* at about 900°C, becomes *orange-red* at 1100° C, *yellow* at 1250°C and finally *white* at about 1600°C. This show that with the increase in temperature of the body, the type of light emitted changes. The light can be seen only when the body becomes red hot. What about a body which is not red hot ? Does it not give any light ? It is found experimentally that before several objects become red hot, they give out a type of light called *infra-red light* which cannot be seen by human eyes.

Infra-red light is placed just before the red light in the visible spectrum (Fig. 6.10). To study this light, glass is unsuitable as it absorbs this light considerably. So the glass prism is replaced by *rock salt prism*. The infra-red light can pass through the fog and mist and so it is suitable for photographing objects, hidden in smoke or mist. It is used to heat the plants in the green houses and to give heat treatment to the human bodies.

If the glass prism is replaced by that of quartz and the spectrum of white light is examined it is found that there is another type of light called **ultra-violet** at the other end of the spectrum after

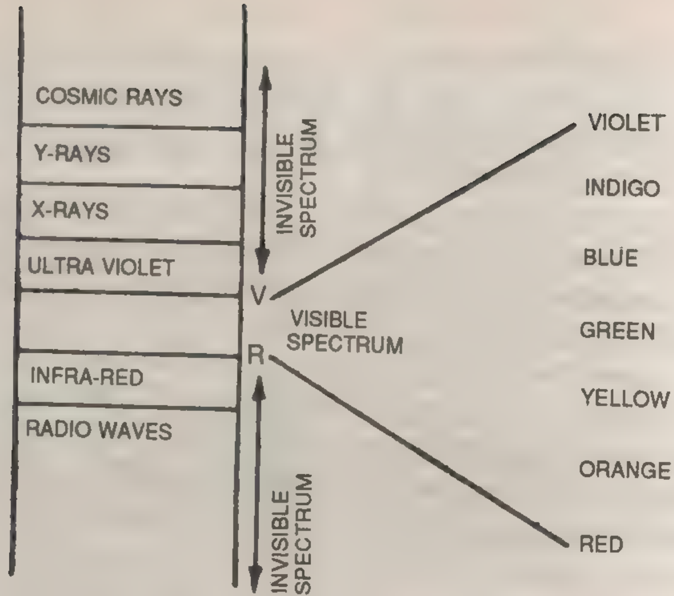


Fig. 6.10 Scheme of lights

the violet light (Fig. 6.10). This light is *invisible, i.e.*, it cannot be seen by the human eyes.

This light is also absorbed by glass. This light is rich in vitamin D, so it is used for curing diseases like rickets and other bone diseases. This light is used for detecting the forgery in documents and in burglar's alarm. It is also used in ultra-microscopes which have high resolving powers. It causes *fluorescence* in certain chemical substances. Gems and presence of certain costly mineral ores is detected by the fluorescence of the ultraviolet light caused by them. An important practical use of ultraviolet light is made in mercury flourescent lamp. A 40 watt flourescent tube light gives as much light as is given by a 200 watt electric bulb.

Scientists have found that there are various other lights which do not affect our sense of sight. We can get an idea of some of these from the scheme of lights shown in Fig. 6.10. Is it not surprising that our sense of sight is limited only to the visible part (VIBGYOR) of this spectrum ? It is interesting to know that the sense of light of some animals is affected by some lights outside the visible part of the spectrum. For example, honey bees can see colours beyond the violet.

6.8 Eye and the Moving Objects

So far, we have known how our eyes can get deceived in judging the colour of a body. Let us now study about our eyes and moving objects.

Hold two parallel pencils A and B in front of your eye in upright positions

at different distances from the eye as shown in Fig. 6.11. If the eye is in the

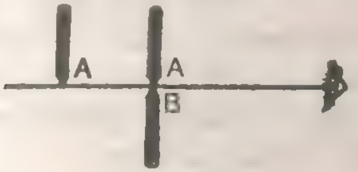


Fig. 6.11 Parallax

same lines as the tips of the pencils, these will appear to coincide. Now, move the eye to the right, the pencil A will appear to move with the eye and the pencil B will appear to move away from the eye and hence the two pencils will appear to separate from each other. Move the eye to the left, the pencil A also appears to move towards the left and the pencil B will appear to move towards the right. This shows that when *the two objects are not placed at the same distance from the eye, a relative displacement takes place as the eye is moved towards the right or left.* This phenomenon is called **parallax.** While moving in a train we find that the nearby trees appear to move away from us faster than trees farther away which appear to move with the train. In other words, because of parallax, the object farther from the eye moves in the same direction in which the eye is moved.

Now, slowly bring the distant pencil A towards the pencil B. As these approach each other, their relative displacement will appear to decrease as the eye is moved sideways. When the tips of the two pencils are in the same vertical line, *i.e.*, when A is brought to the position A′ and lies above B there is no relative displacement when the eye is moved sideways, *i.e.*, the two pencils appear to move together. In this case parallax is said to have been removed.

Our eye deceives us yet in another way. The effect of the image of an object on the retina of a human eye remains for about 1/16th of a second after the object has been removed. This is known as the *persistence of vision*. If a number of *still* pictures are projected on a screen at the rate of about thirty-two in one second, then before the impression of one picture dies out, the impression of the second picture is formed. So the projected pictures appear to blend into one another and, thus, produce an illusion of a moving picture. This principle is used in *cinematography*. The cinema film is made by a movie camera which records the action in a series of pictures. In one second about thirty-two pictures are taken. These pictures are projected on a screen practically at the same rate by the projector to produce the same action on a screen.

Activity 6.3

Take a piece of cardboard. Draw a lion on one side of the cardboard and a forest on its reverse. Next fix a pencil firmly on the middle of this card board. Hold it in between the plams of your hands. Move the hands forward and backward to rotate the pencil swiftly. Watch the cardboard. What do you notice? Does the lion appear to be in the forest ? Why ?

6.9 Rainbows

Rainbows are formed in the same way as the spectrum is formed by a glass

prism. They are formed not by glass but by tiny drops of water suspended in the sky soon after rainfall. The white beam of light comes from the sun and passes through these spherical transparent water drops (Fig. 6.12). On coming out of the drops, the white beam is splitted into the seven colours of the rainbow.

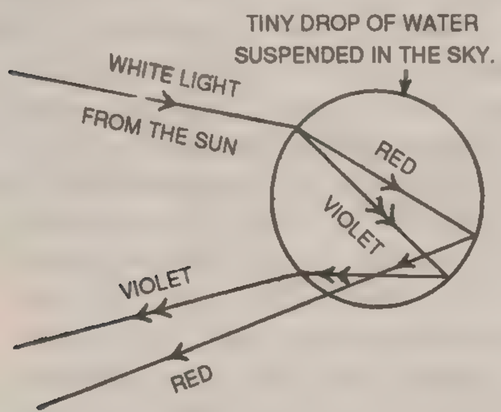


Fig. 6.12

6.10 Spherical Lenses

A lens is a piece of transparent substance enclosed by two surfaces, one spherical and the other spherical or plane (Fig. 6.13). *Convex* (*converging*) lenses are thicker at the centre than at the edges. *Concave* (*diverging*) lenses are thicker at the edges than at the centre. The *principal axis* of a lens is the line passing through the centre of each surface.

To observe images formed by lenses

Concave lens. Look through a concave lens at a near object and men at a distance object.

Convex lens

1. Hold a convex lens close to the printed page of a book.

2. Slowly increase the distance between the lens and book (object distance).

3. Look at a distant object through a convex lens held at arm's length from your eyes.

The principal focus of a lens is the point on the principal axis at which rays

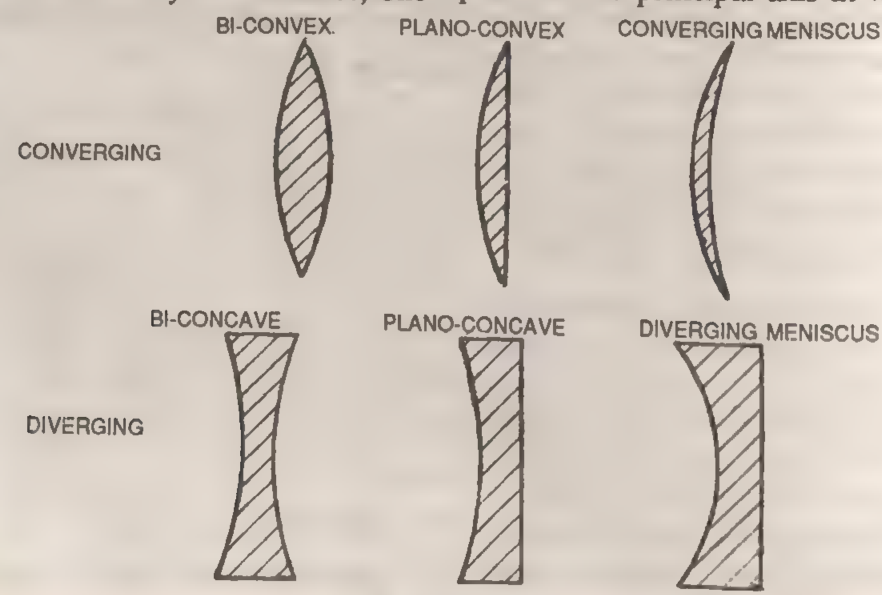


Fig. 6.13 Lenses

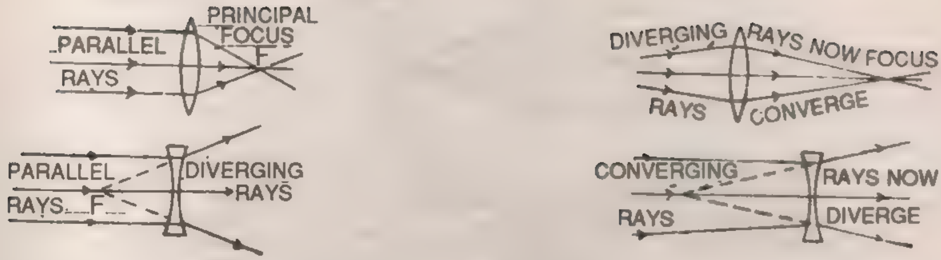


Fig. 6.14. How lenses refract

parallel to the axis converge after refraction (convex lens) or from which the rays appear to diverge after refraction (concave lens) (Fig. 6.14). The focal length of a lens is the distance between the principal focus and the centre of the lens.

The principal focus of a convex lens is *real* because (*a*) it can be seen on a screen, and (*b*) rays of light pass through it. The principal focus of a concave lens is *virtual*. Thicker lenses refract light more and have shorter focal lengths than thinner ones. A lens has a principal focus on both sides. They are at the same distance from the lens.

How a lens acts

A lens acts as a number of prisms (Fig. 6.15). A prism refracts light towards its base. The outside 'prisms' of a convex lens have large refracting angles and refract the light inwards more than the central 'prisms'. Therefore the rays converge. A concave lens makes the rays diverge.

To measure the sizes of images formed by a lens

Place a convex lens vertically in a lens holder. Place a luminous object (e.g., a burning candle or cross-wires illuminated by a ray box) about one metre from the lens. Move a white screen on the other side of the lens until a sharp image is formed on it. The image is *diminished, inverted* and *real.*

Move the object towards the lens. The image is larger and farther away from the lens, *i.e.*, the image distance increases.

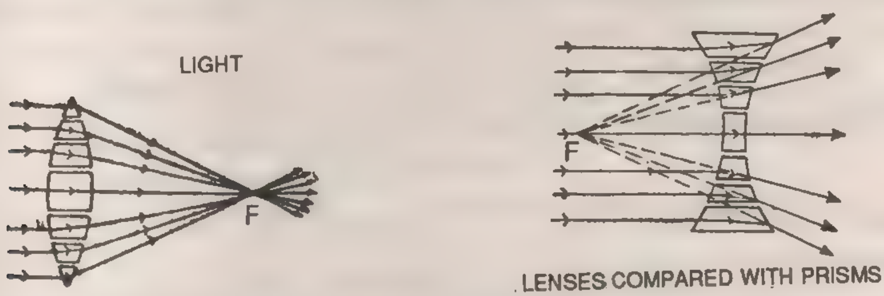


Fig. 6.15 A lens acts like many prisms

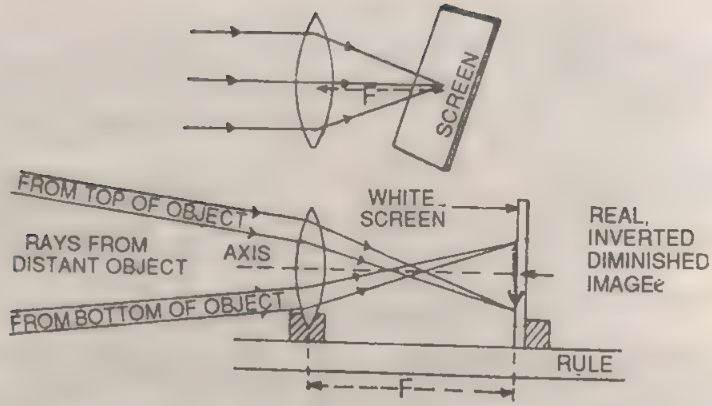


Fig. 6.16 Focal length of converging lens

Move the object nearer still to the lens. At some places, no image can be formed on the screen (the image is virtual).

Measure the sizes and distances of the object and image formed in various positions. Use your results to confirm this formula :

$$\frac{\text{Size of image}}{\text{Size of objects}} = \frac{\text{distance of image from lens}}{\text{distance of objects from lens}}$$

To find the focal length of a converging lens

Using a distant object. Hold a convex lens in sunshine so that light passes through it to a white screen. Move the screen until a small sharp shot of light forms on it. Measure the distance between the screen and the centre of the lens. This is the focal length. The screen may start to burn if the sun's rays are powerful, because heat rays also come to a focus. Repeat several times. The average of the reading is the focal length, f.

Graphical construction of images

The position and size of an image can be found graphically by using two rays drawn from the top of the object.

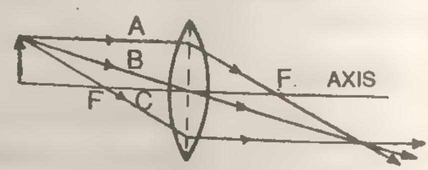


Fig. 6.17 Three rays used to construct images

Before refraction	After refraction
1. Parallel to principal axis	Through the focus (convex) From the focus (cancave)
2. Through centre of lens	Goes straight on
3. Through or towards principle focus	Parallel to axis

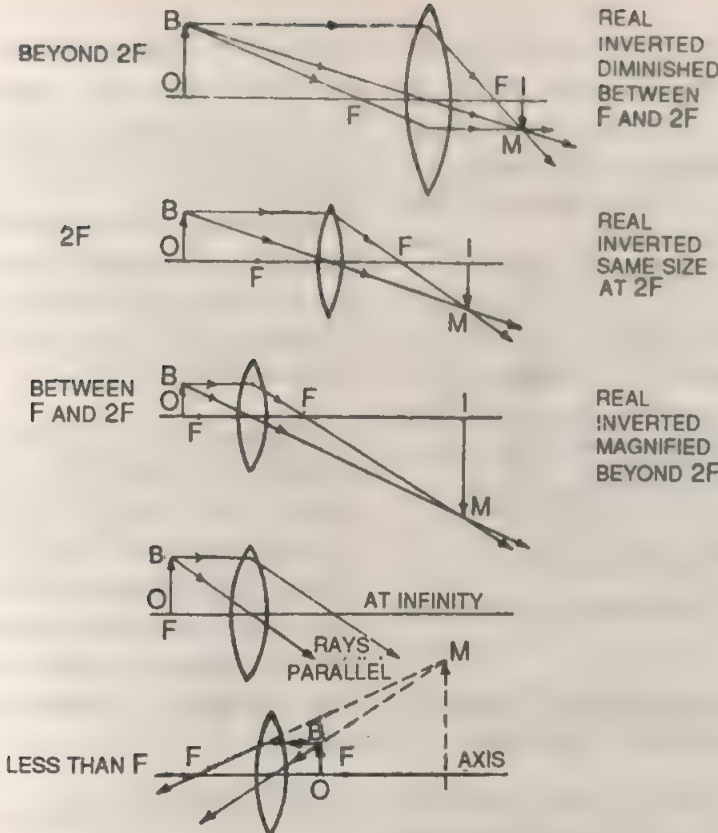


Fig. 6.18 Images formed by convex lens

Images formed by convex lens (focal length f)

Object distance	*Image distance*	*Characteristics and uses of image*
Infinity–2f	f–2f	Real, inverted, smaller Eye and Camera
2f	2f	Real, Inverted, same size Copying camera
2f-f	2f-infinity	Real, inverted, larger, Photographic enlarger and projection lantern
f	Infinity	No image. Parallel beam Searchlights
Less than f	Greater than object-distance	Virtual, erect, larger Magnifying glass.

Note that as the object distance becomes smaller the image distance becomes larger. The image and object are always on opposite sides of the lens except when the object distance is less than f (last example above).

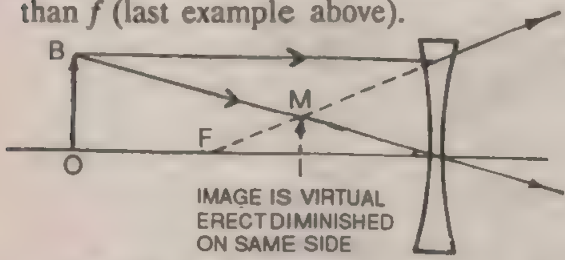


Fig. 6.19 Image formed by concave lens

Images formed by concave lens

The image is always *virtual, erect* and *diminished*.

6.11 To use a convex lens as a magnifying glass (Simple Microscope)

Open a page of your book and hold a convex lens between the book and your eye. First hold it very close to the book and then gradually move it towards your eye. Record your observations.

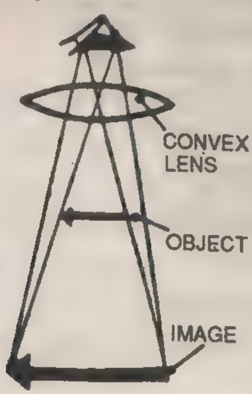


Fig. 6.20 A convex lens as a magnifying glass

You will notice the following :

(a) that the letters in the book are just about the same size when the lens is moved very close to them, but that they get rapidly bigger and bigger as the lens is gradually moved up towards the eye ; they remain erect throughout ;

(b) that a point is reached when the letters can no longer be seen through the lens, but that a little later they reappear as inverted, and large letters now begin to get smaller.

Explanation : You have learnt how the lens formed the images of the objects (letters). But it is useful to note here that the *erect*, enlarged images of the letters (Fig. 6.20) seen through the lens are *virtual* (*i.e.*, they cannot be collected on the screen) and that we get such images only when the object is between the lens and its focus.

6.12 The Concave Lens

If you try to perform the above experiments with a concave lens you will obtain entirely different results.

In the first place, your paper or cloth will not burn no matter how long you hold the concave lens above it, under the brightest sunshine. As has been shown before, only *virtual* image of the sun will be formed, and so it cannot be collected on the cloth or on the screen.

Secondly, no matter how much we try, no image of the well-lit house or tree can be collected on the screen by a concave lens. Thirdly, the letters of a book seen through a concave lens appear smaller in size but they remain erect, as in the case of the convex lens. They appear

smaller and smaller as the lens is moved nearer to the eye.

The concave lens forms a *virtual, erect* and *diminished* image of all objects placed in front of it and at any distance from the lens. You will learn in higher classes how these images are formed.

6.13 Some uses of lenses (Optical Instruments)

Lenses are used very widely in almost all optical instruments. A few of these will be discussed here.

1. *As a magnifying glass*. Convex lenses can be used in reading, to magnify small print.

They are used as hand-lenses in biology to examine the minute structure of leaves and other tissues which the normal eye cannot easily see.

They are used by watch repairers and goldsmiths to enable them to see the very tiny things they have to handle.

They are attached to covers of small watches, especially those with dates, to enable the date to be read easily.

They are also used to read thermometers and barometers and other measuring instruments when the graduation lines are so close that the eye cannot easily read them.

2. **The Photographic camera** Convex lenses are used in the camera. This consists chiefly of a convex lens and a sensitive film or plate forming the screen, all being enclosed in a box painted black on the inside to prevent any light affecting the film. Fig. 6.21 shows the working of a folding camera. EGHF is the camera, O being the camera lens and GH being the film or plate. AB is the object whose photograph is being taken. A beam of light from it passes through the lens and forms an inverted image of the object on the sensitive film or plate. You 'take' the photograph by allowing light to pass through the lens for a very short time, depending on how much light is available. This light will affect the film or plate according to how much of it reaches different parts of the film, that is, according to the image of the object formed on it.

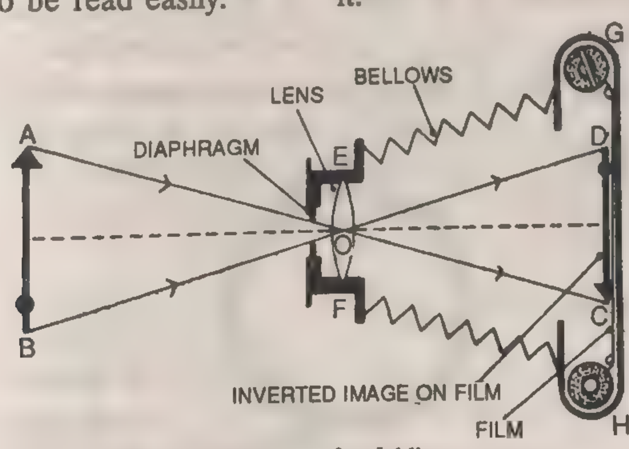


Fig. 6.21 Diagram of a folding camera

After the photograph has been taken the film is removed in the dark room and treated first with a chemical solution known as the developer and then with the fixer. It is then brought out and dried. The product is called the *negative.*

By allowing light to pass through this negative on to a sensitive card known as the printing card, a *positive* can be obtained. This positive is the finished product commonly called the *photograph* of the object. You should visit a photographer's dark room to watch these processes of developing and printing.

Some parts of the camera are worthy of note.

(a) **The shutter,** *i.e.,* the window which opens only for a fraction of a second to admit light. This is operated by the photographer when everything is set.

(b) **The diaphragm,** *i.e.,* the stop which the light enters the camera. This hole can be made narrower or wider to control the amount of light coming into the camera. In dull weather it is widened, while in bright sunshine it is made narrower and smaller.

(c) **The bellows.** This is made of leather blackened inside and outside. It is used to focus the image on the film or plate. This means that it is used to move the screen (*i.e.*, the film) to and fro until the sharpest image of the object is produced on it. Cheap box cameras have no bellows, and so no focusing can be done, since the distance between the lens and the film is fixed.

3. The Eye and its parts

Look at the eye of a human being, ox, sheep, rabbit, etc.

The eyeballs are the organs of sight. They are in bony orbits of the skull, and are also protected by eyebrows. Each eyeball can be moved by six muscles. An eyeball has three coats : sclerotic, choroid and retina (Fig. 6.22).

(a) **Sclerotic** is the opaque touch coat called the white of the eye. At the front is the transparent window, the *cornea.* The sclerotic protects the delicate parts inside.

(b) **Choroid.** This black coat contains blood vessels that supply food and oxygen to the eye. It absorbs stray light in the eye. It thickens and forms *ciliary muscle* at the front.

(c) **Retina.** This covers the side of the eye. Its many nerves pass light im-

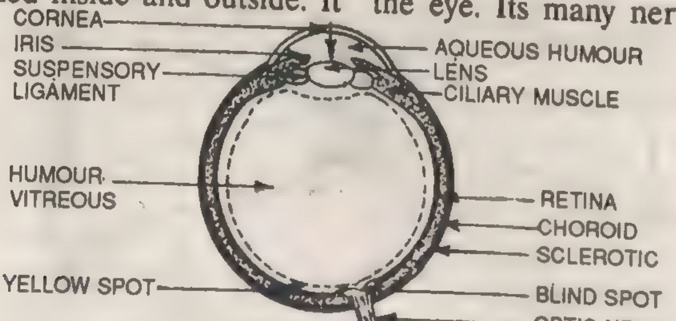


Fig. 6.22 The Eye

pulses to the optic nerve, which then transmits them to the brain. The brain interprets the impulses. Images on the retina are inverted but the brain 'sees' them correctly.

(d) **Blind Spot.** This is at the point where the optic nerve leaves the retina. Demonstrate it by making two marks 7 cm apart, on paper. Hold it at arm's length and gradually bring it to one eye, with the other eye closed. Look at one of the marks. When the image of the other is at the blind spot, you do not see it.

(c) **Yellow spot.** This is the spot of clearest and most distinct sight. When you look at anything very carefully, its image is at this spot.

(f) **Iris.** This is the coloured part of the eye. Light passes through a hole, the *pupil*, in it. The iris makes the pupil narrow in bright light and wide in dull light and thus prevents damage to the eye. Its action is automatic (a reflex action) and cannot be controlled.

(g) **Aqueous humour.** This is a watery liquid between the cornea and the eye-lens. It refracts the light.

(h) **Vitreous humour.** This is a jelly-like liquid between the eye-lens and retina which keeps the eye-ball in shape. It also refracts the light.

(i) **Eye-lens.** This is soft, elastic and convex (converging). Ciliary muscles which pull on ligaments make it thicker or thinner and it therefore focuses the image on the retina.

(j) **Optic nerves.** These are the nerves of sight which join the nerves of the retina to those in the brain. These are of two types – the *rods* which are sensitive to dim light and *cones* which are sensitive to bright light and the colours.

(k) **Accommodation** is the focusing of an image by alteration of the thickness of the eye-lens, normally, people can accommodate to focus images of objects between 25 cm and infinity from their eyes. The power of accommodation decreases as people become older.

The eye and the camera

Similarities are :

Camera	Eye
Convex lens.	Convex lens.
'Stop' controls light.	'Iris' controls light.
Shutter keeps out light.	Eye-lids keep out light.
Image forms on film.	Image forms on retina.
Black paint stops internal reflexion.	Black layer (choroid) stops internal reflexion.
Air (transparent) between lens and film.	Jelly (transparent) between lens and retina.
Both form small, inverted images.	

Differences are :

Camera	Eye
Lens is hard glass.	Lens is soft and elastic.
Thickness of lens does not change.	Thickness does change.
Usually, image is focused by moving lens.	Image is focused by making the lens thicker.
Only the lens refracts (bends) the light.	The aqueous and vitreous humours also refract.
'Stop' can be altered.	Iris alters by itself.

Why you need two eyes

Close one eye. (*a*) Throw a ball into the air and than try to catch it. (*b*) Hold the arms wide apart, with one finger of each hand sticking out. Bring the hands together so that the two fingers are almost touching. (*c*) Stand a pencil upright on a table. Try to knock over the pencil with a pin. Is it easy to do these things ?

The images formed by each eye are not identical. The brain interprets the correct idea of depth or distance and we 'see' an image in three dimensions. The image formed by one eye is flat like a picture or photograph. A single image seen by both the eyes is called *binocular vision*.

Short sight (Myopia)

A shortsighted person cannot see distant objects clearly. The eye-lens is too thick (or the eye-ball is too long). Parallel rays come to a focus *in front of the retina.*

Short sight is corrected by spectacles with diverging lenses (concave lenses).

Long sight (Hypermetropia)

A long-sighted person cannot see near objects clearly. The eye-lens is too thin (or the eye-ball is too short from back to front). Rays from near objects come to a focus *behind the retina.*

Long sight is corrected by spectacles with converging lenses (convex lenses).

Loss of accommodation

As people grow older, the ciliary muscles lose their power of making the eye-lens thick enough to focus near objects clearly. Also, the eye-lens becomes less elastic and may not be thin enough to focus distant objects clearly. An old person usually requires spectacles for reading, and may also require other spectacles for looking at distant objects.

The structure of eyes of all animals having back-bone is the same as ours. But in the case of some animals like cow, dog, horse etc., where eyes are present on each side of the head, one eye sees objects of one side and the other eye sees

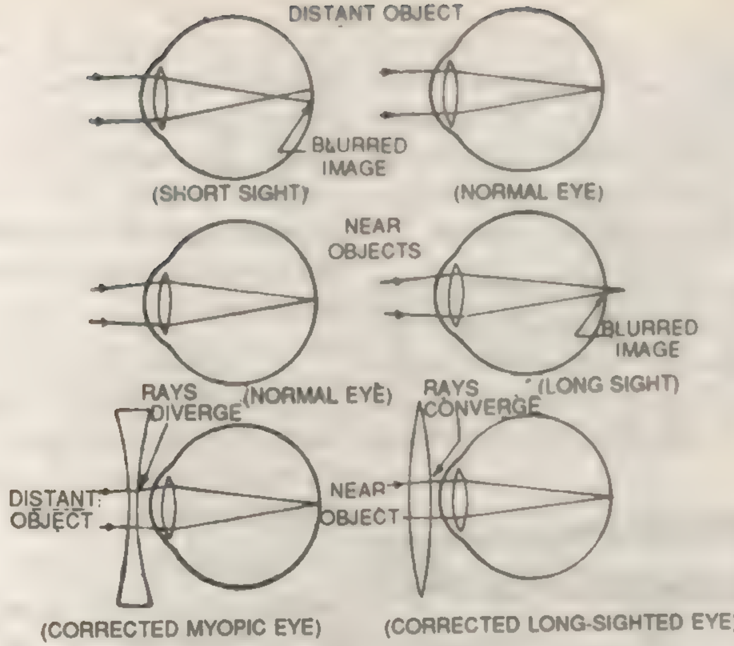
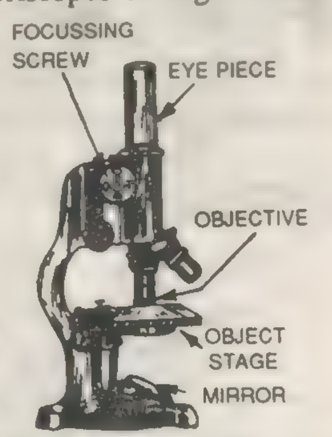


Fig. 6.23 Defects of Vision

the objects of another side. They can focus only through one eye at a time that is, they use only one eye at a time. This is called *monocular vision*. The image formed is flat and thus they are not able to judge the distance between two objects. The insects and a few other animals have compound eyes. Each compound eye is made up of a large number of small units each one comparable to our eye. In bright light each unit forms an independent image. But in dim light all the units together form a single image. Some insects, like the honeybee can see certain rays which are invisible to the human eye.

4. Microscopes, Telescopes and Binoculars :

A microscope is an instrument which enlarges an object. In fact, the magnifying lens already discussed is a *simple microscope.* Its magnification is about 5 to 10 times the size of the object. When more than one lens is used it becomes a *compound microscope.* A telescope and binoculars are instruments which make distant objects bigger and are used to observe the moon, the stars or to watch events taking place some distance away. Telescopes are also used in conjunction with periscopes during warfare.



COMPOUND MICROSCOPE

Fig. 6.24

These instruments are constructed by a suitable combination of two or three lenses. Your teacher will demonstrate them to you and you should examine them closely. You will learn later in your higher studies how the images are formed.

In these instruments the lens that faces the object is called the *objective* and the one next to the eye is called the *eye-piece*. Figs. 6.24 and 6.25 illustrate the compound microscope and the telescope.


A TELESCOPE

Fig. 6.25

In a compound microscope, the objective forms a real magnified image of an object kept just beyond its focal length. The eyepiece acts as a magnifying glass to observe the image formed by the objective. The eyepiece finally produces a highly magnified virtual image of the object.

In a telescope, the objective forms the real image of the distant object at its focus. The eyepiece acts as a magnifying glass and produces a magnified virtual image of the first image (Fig. 6.26).

The motion of the moon and the planets was studied by using a telescope for the first time by *Galileo,* an Italian astronomer. (6.28)

Binocular

You may have used yourself, or have seen some people using an instrument for watching a cricket test match, hockey match, music programme, etc. This instrument used to see objects distinctly is called a *binocular.*

A simple binocular has two telescopes which make the distinct image of the object at a far distance, very close to you. Each telescope is a Galelian type, having objective lens as a convex lens eyepiece

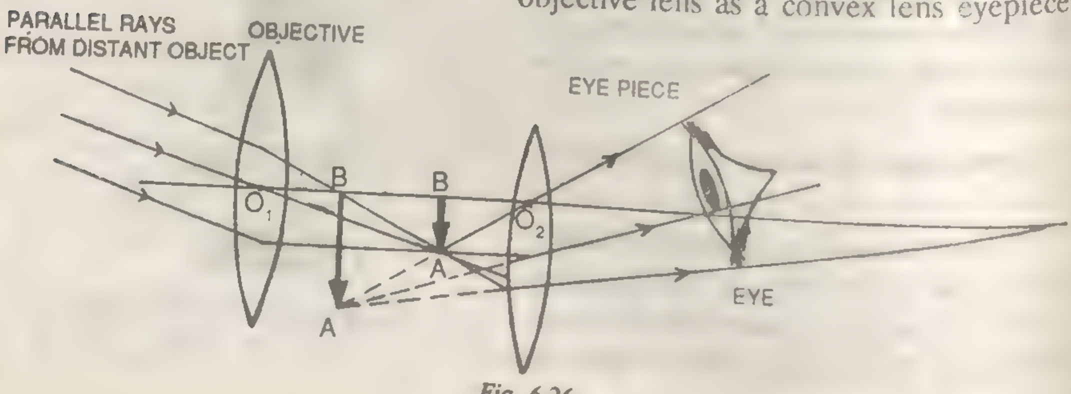


Fig. 6.26

as a concave lens (see Fig. 6.28). The distance between the two lenses can be adjusted by a screw 'P' (see Fig. 6.27) to get a distinct image of the object.

There are prism binoculars which use prisms in addition to convex and concave lenses. By doing so magnification power of a binocular increases and we can see the objects at far distances more distinctly and enlarged.

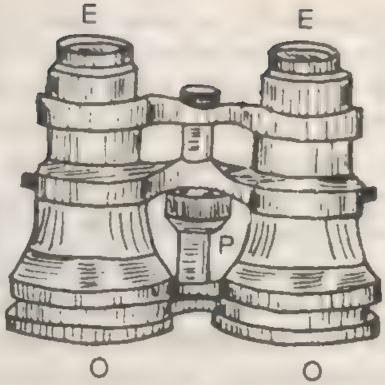


Fig. 6.27

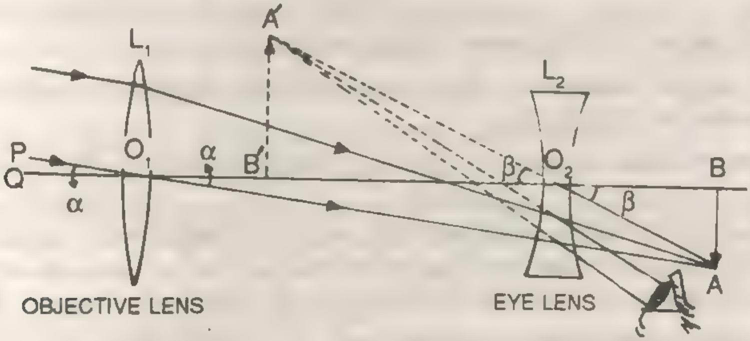


Fig. 6.28

SUMMARY

1. The bending of a ray of light when it passes from one optical medium to another is called refraction of light.

2. Whenever a ray of light passes through a parallel sided glass slab, it emerges parallel to the incident ray and hence gets displaced from its original path. The displacement suffered by a ray of light depends upon the thickness of the glass slab. The greater the thickness, the more is the displacement.

3. When a ray of light passes through a prism, it is bent twice towards the base of the prism.

4. When a ray of white light passes through a glass prism, it emerges as a beam of coloured light–a band of seven colours (VIBGYOR). This band of seven colours is called spectrum.

5. The seven colours in the order are :

Red, Orange, Yellow, Green, Blue, Indigo and Violet

The Red is the least deviated and the Violet suffers the most deviation.

6. The seven colours of the spectrum can be combined to give white light.

7. The rainbow is formed by dispersion of sunlight by spherical rain drops floating in the air.

8. Colours of objects depend on the colours of light they reflect or transmit. Basic or primary colours (red, green and blue) will reflect or transmit only their respective colours ; other coloured objects will reflect or transmit other colours along with their respective colours.

9. Lights of different colours can be mixed to get different colour effects. The colour of light obtained by mixing two coloured lights is different from the colour of paint obtained by mixing corresponding coloured paints, because light gives a pure colour and that of paint pigments is impure.

10. Three primary colours (red, green, and blue) can be used to obtain a large number of secondary colours. There are several lights other than those we can see.

11. Human eye is deceived in seeing the colour of a body and also in some other ways. Stationary pictures when moved at a suitable speed appear to form the view of an action as seen in a cinema.

12. Our sense of sight is not limited only to the visible part of the spectrum. Spectrum extends beyond red on one side and beyond violet on the other side. Infra-red is placed before red light and ultra-violet light is after violet in the visible spectrum.

13. Sense of light of some animals is affected by some lights outside the visible part of the spectrum.

14. The image of an object persists on the retina of a human eye for about 1/16th of a second after the object is removed. This is known as persistence of vision.

15. The relative shift between two objects situated at different distances from the eye when the eye is moved sideways is called parallax.

16. There are two types of lenses. Convex or converging, concave or diverging.

17. The focus of a lens is the point at which rays coming from a distant object converge or from which they seem to diverge, on passing through the lens. It is a real for a convex lens but virtual for a concave lens. The distance between the focus of the lens and the lens is known as the focal length of the lens. This is different for different lenses and is a very important property of lenses.

18. As an object is moved towards a convex lenses, a real, inverted image is formed which gets bigger and bigger until an erect and enlarged virtual image is produced when the object is moved sufficiently near.

19. A concave lens gives a virtual, erect and diminished image of an object, no matter where the object is.

20. Lenses are used as magnifying glasses ; in cameras ; in spectacles, in microscopes; and telescopes etc.

21. A lens in human eye also forms images.

22. The human eye can see distant and nearby objects by adjusting its focal length. It can have two main defects of vision – short-sightedness and long-sightedness which can be corrected by wearing spectacles of suitable focal lengths.

23. The human eye is most sensitive to certain colours (green and yellow). The human eye can be compared with a photographic camera.

24. In a camera a convex lens focus the image of an object on a photographic plate for a very short exposure when shutter is opened.

25. A convex lens works as a magnifying glass (simple microscope).

26. In a compound microscope there are 2 or more than 2 lenses which make a much enlarged image of an object at a very close distance.

27. A telescope is an instrument to see the objects at far distances distinctly. It is made of lenses.

28. A binocular is a more convenient instrument to see the far objects distinctly. It is made of lenses and prisms.

QUESTIONS

1. (a) What is refraction of light ? Define refracted ray of light, Angle of Incidence and Angle of Refraction.

(b) Give some examples of refraction of light from our daily life.

2. (a) Distinguish between an optically denser medium and an optically rarer medium.

(b) Discuss refraction of light through a glass prism. What is angle of deviation?

(c) Discuss refraction of light through a rectangular glass slab.

3. (a) What is dispersion of white light ?

(b) What is spectrum of white light ?

(c) How will you show that white light is composed of seven colours ?

4. Give reasons for the following :

(i) A stick partially immersed in water appears bent.

(ii) Ponds appears shallower than they are.

5. If a substance was perfectly transparent, would we be able to see it ? Explain your answer.

6. Complete the following sentence :

When a ray of light is going from a less dense medium into a denser medium it is bent................ the normal bent when it is going from a denser medium into a less dense one it is bent .... the normal.

7. Draw a diagram showing the path of a ray of light through a parallel sided glass block. Label the following:

incident ray ; refracted ray ; emergent ray ; normal, angle of incidence ; angle of refraction and angle of emergence.

8. Draw a diagram showing the path of light through a triangular glass prism. Mark the angle of deviation.

9. Draw a diagram to show how the eye sees a 50 paise coin placed at the bottom of some water in a bucket.

10. Does light travel faster in air or in water ? Suppose light is travelling from water into glass. In what direction will it bend ?

11. Fill in the blank spaces :

When a ray of light strikes a smooth surface and is sent back, it is said to be .... ; when it enters a transparent object and becomes bent, it is said to be .... ; when it enters a substance and does not emerge at all, it is said to be ....

12. What name is given to the splitting of light into various colours by a prism?

13. Show in a diagram why a parallel sided glass block does not split white light into the colours that make it up.

14. (i) Name the primary colours, state three of their properties.

(ii) Explain why a book appears red when seen through a red transparent piece of glass but black when seen through a green one.

(iii) Explain why one book appears red to the eye, and another green.

(iv) Are white and black also colours?

15. Fill in tne following table the colours of the articles shown in column one when treated as shown in the other columns :

In day light	*In green light*	*In red light*	*Though green glass*	*Through red glass*	*Through blue glass*
(a) White paper					
(b) Red rose					
(c) Green leaf					
(d) Blue ribbon					

16. (a) What will a red flower look like in yellow light ?

(b) Why does a peice of cloth seen under artificial light look different when seen in day light?

(c) A beam of blue light is allowed to fall on black, white, red and blue surfaces in turn. Describe how each appears.

17. Show by experiment that the various colours of white light will not be bent equally by glass. Which colour is bent the least and which the most ?

18. (a) What is the difference between visible spectrum and invisible spectrum of white light?

(b) What is infra-red light ? Mention some of its properties and uses.

(c) What is ultra-violet light ? Mention some of its uses.

19. What is persistence of vision ? Explain how this effect could be used (i) in cinema houses, (ii) for recombining the colours of the spectrum.

20. (a) What is Parallax ? Give an example.

(b) How Rainbow is produced in the sky ?

21. You are given three flowers A, B and C in a dark room. When seen through yellow light, A appears black, B appears yellow and C appears yellow. When seen through red light A appears red, B appears black and C appears red. What colours are A, B and C when seen in day light ?

22. Fill in the following table :

Colour Mixed	*Resulting colour of light*	*Resulting colour of paint*
Red + Blue		
Red + Green		
Green + Blue		
Red + Blue + Green		

23. (i) Can we say that black and white are also colours ?

(ii) How may colours are there ?

(iii) Are otners some lights which we cannot see ?

24. Fill in the blanks :

(a) The prism is able to split .... light into its .... colours because the glass can .... the different colours by .... amounts so that on coming out of the prism they come out .... at different ....

(b) Yellow colour can be formed by mixing .... and .... purple by mixing .... and .... and .... by mixing blue and green.

25. (a) What are the two things needed for vision ?

(b) What is a pinhole camera ? Upon what principle does it work ? Explain how it forms an image of an object. What is the nature of the image formed by it ?

26. What is the difference between a mirror and a glass sheet ?

27. Why do some mirrors show distorted images ?

28. Are the images in curved mirrors of sizes different from the size of the object ?

29. Why do we hold a magnifying glass very near the object ?

30. We have two eyes, but why do we see a single image ?

31. What is the difference between a telescope and a microscope ?

32. How can we focus distant and near objects with our eyes ?

33. How can we distinguish colours with our eyes ?

34. Why do some old people use two different types of glass (spectacles) ?

35. (a) Give the structure of the human eye.

(b) What are the two main defects of vision and how are they corrected ?

36. (a) What is the principal focus of a :

(i) Concave lens (ii) Convex lens ?

(b) Draw diagrams showing how a convex lens can form

(1) a real image (2) a virtual image.

37. (a) State three characteristics of the image formed by a camera.

(b) Compare the methods of focusing in the eye and in a lens camera.

(c) How is the amount of light passing through the lens changed in

(i) the eye and (ii) a lens camera ?

38. (a) Explain how a person who is short-sighted fails to see distant objects clearly. Give diagrams.

(b) When the image of a distant object is focused in the vitreous humour of the eye, from what defect does the eye suffer? Give a diagram.

(c) State the functions of the following parts of the eye :

(i) Cornea, (ii) Iris, (iii) Retina.

39. As a well-lit object is moved from any large distance towards a convex lens, describe the image of it produced by the lens with respect to the following :

(a) Whether it is on the same side of the lens as the object or on the other side,
(b) Whether it is real or virtual,
(c) Whether it is erect or inverted,
(d) Whether it is enlarged, diminished or of the same size.

40. How much near to the book must you hold a convex lens if you want to use it as a magnifying glass ?

41. Strike off the words that do not apply in the following sentence :

An object placed anywhere in front of a concave lens will give an image which is real/virtual, erect/inverted, enlarged/diminished/the same size.

42. State the three things that may happen to a beam of light striking a body.

Which of the three are most likely to occur when a beam of light strikes the following :

(a) a plane mirror (b) a plane glass
(c) a polished table (d) coal tar.
(e) a perfectly transparent body. (f) a piece of diamond.
(g) a black cloth (h) water (i) stained glass.
(j) to send out a parallel beam of light.

43. Use diagrams to show why concave lenses are called diverging lenses while convex lenses are called converging lenses.

44. Describe the series of images formed by (a) a concave lens (b) a convex lens, as the lens is moved toward a printed page.

45. What changes would you observe in your image as you moved nearer to:
(i) a concave lens and (ii) a convex lens.

46. Define :

(i) Optical centre.
(ii) Principal focus of a lens.
(iii) Focal length of a lens.

Show them by means of diagrams.

47. Fill in the blanks with suitable words.

(i) We use .... as magnifying glasses. They are also used in .... and ....
(ii) The image formed by a concave lens is .... and .... than the size of the object.
(iii) The two main defects of vision are .... and ....
(iv) A .... also forms images in human eye.
(v) The human eye is most sensitive to .... and .... colours.

CHAPTER 7

MAGNETISM

7.1. Introduction to Magnets

Long ago, the story goes, a shepherd boy was keeping his sheep on a hillside near a Greek city called Magnesia. A great storm arose. The boy ran for shelter to a cave. He held his crook (a stick with an iron handle) in his hand. When he got into the cave his crook was snatched from his hand. The boy did not see anyone. He was very frightened. He saw his crook hanging from the roof. He got it back after some struggle. He thought that the roof of the cave had some strange power. Whenever he held his crook up towards the roof, it jumped out of his hand and hung there. But when he turned it upside down and held the wooden end up towards the roof, nothing happened. Again, when he held the iron head of his crook towards the roof, it jumped out of his hand. Only the iron end held there.

This strange thing puzzled the boy. When the storm was over he tried to find the answer but he did not succeed. At last a wise old man explained it to him. The roof of the cave was made of a black rock with iron in it. The iron has special powers. It could attract other pieces of iron which had not got this power, to itself.

Years later, this iron rock came to be called Magnetite, a dark coloured ore, composed or iron and oxygen (Fe_3O_4). Look at the first six letters of the word magnetite. What do they spell ?

This is where the story of magnets begins. Magnetite was known from ancient times to possess the following two characteristic properties :

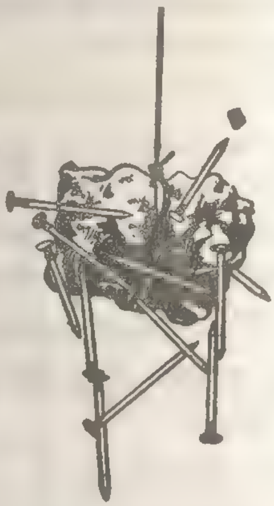


Fig. 7.1. Lodestone.

(i) **Attractive Property.** When a lump of magnetite is brought in contact with small pieces of iron, it picks them up.

(ii) **Directive Property.** When a bar of magnetite is suspended freely at the end of a fine thread, it oscillates to and fro and finally comes to stay with its ends always directed along the north and the south of the earth approximately.

This directive property was used by the ancient sailors to guide the course of ships on the sea. Hence, they called

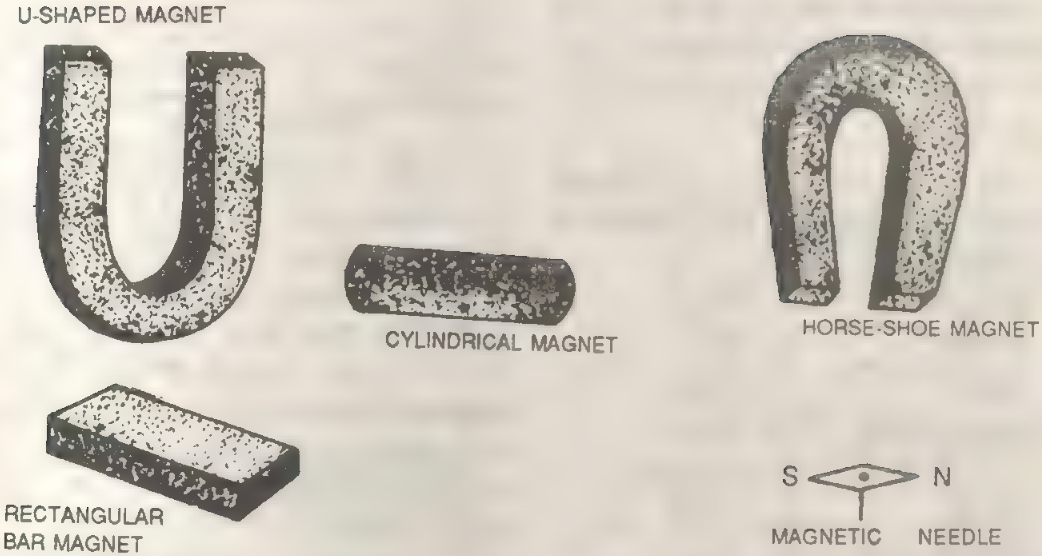


Fig. 7.2. Magnets of different shapes.

magnetite a Lodestone, which means a leading stone.

Any substance which, like the lodestone, has the above mentioned two characteristic properties *i.e.,* attractive and directive, is called a *magnet.*

Since magnetite can be mined from the earth it is called a *natural magnet* and is found in many places *e.g.,* Canada, Finland, Norway, etc.

Natural magnets like the lodestone are irregular in shape and have weak attractive and directive properties.

Magnets can also be made by artificial means and such magnets are called *artificial magnets.* Magnets are made of different materials. Many magnets are made of iron and steel. Some magnets are made of mixtures of aluminium, nickel, cobalt and iron and have trade names such as Alnico. Such magnets are very strong. Ferrite magnets are made from a powder of iron oxide and either barium oxide or strontium oxide. These magnets are brittle and have the properties of ceramics. Magnets are of many shapes. Some are cylindrical rods and some are rectangular bars. They are called 'bar magnets'. Some are U-shaped. Some are called 'horse-shoe magnets' because they look like horse-shoes. There is also one made up of a thin piece of magnetised steel with two tapering ends-kept balanced on a vertical pivot ; it is called the *magnetic needle.*

7.2. Magnetic and Non-magnetic Materials

A substance which is attracted by a magnet is called a *magnetic substance.* A substance which is not attracted by a magnet is called a *non-magnetic substance.*

A magnetic substance can be made into a magnet whereas a non-magnetic substance cannot be made into a magnet.

Activity 7.1

Use a magnet to find out whether the following substances are magnetic or non-magnetic :

1. Ruler	2. Pencil
3. Comb	4. Tin
5. Glass	6. Nail
7. Screw-driver	8. Coin
9. Scissors	10. Matchbox
11. Chalk	12. Cork
13. Thumb tack	14. Eraser
15. Clothes peg.	16. Rubber band
17. Copper wire	
18. Plastic tooth brush.	

7.3. Magnetic Poles–The strongest parts of a magnet.

A magnet has an attractive force on magnetic materials. Is the attractive force the same all over a magnet ?

Activity 7.2.

Place a bar magnet in a container having steel clips in it. Pick up the magnet.

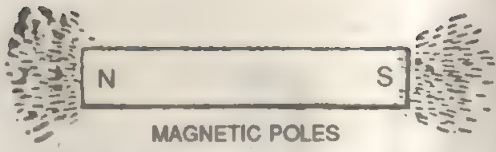


Fig. 7.4. Poles of a bar magnet.

Do any clips cling to the magnet ? Where do most of the clips cling ? By raising the magnet you will see that the clips cling to it in an irregular fashion. Most of them cling to the ends of the magnet. This experiment shows that the ends of the bar magnet have greater magnetic force than the middle portion of the magnet. Repeat the experiment with U-shaped, horseshoe and cylindrical magnets. So the ends of the magnets have greater magnetic force than the other parts ?

The two regions on a magnet which attract more clips are called *poles* of a magnet.

There is a magnetic pole at each end of a magnet. Always there are two magnetic poles on a magnet, no matter what its shape may be.

Suppose, a bar magnet is suspended by a thread of unspun silk or supported on a large cork floating in a dish contain-

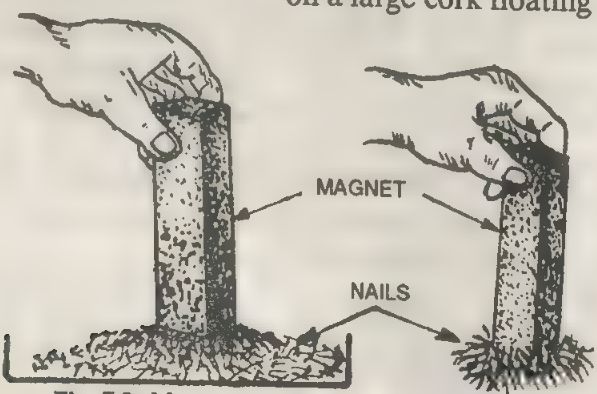


Fig. 7.3. Magnets attract magnetic substances.

ing water. The magnet will be seen to turn and eventually come to rest pointing north and south of the earth. If the end of the magnet pointing north is marked in some way, it will be found that the same end always points northwards. The pole at this end is called the *north-seeking pole* or more often simply the North-pole (N-pole). The other pole of the magnet is then called the *South-seeking* or *South pole (S-pole).*

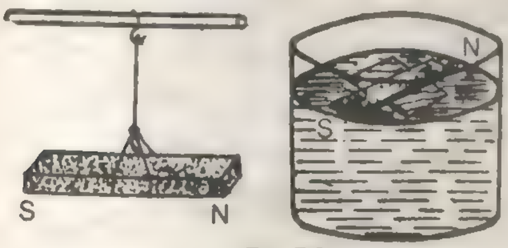


Fig. 7.5

7.4. Interaction of Magnets - Attraction and Repulsion

Activity 7.3.

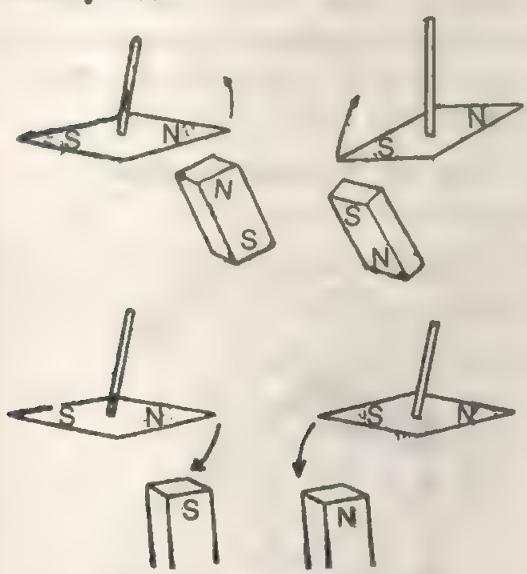


Fig. 7.6

Take a piece of unspun thread, one magnetic needle and one bar magnet. Hang magnetic needle as shown in Fig. 7.6 so that it can rotate freely. The needle will be seen to turn and eventually come to rest pointing north and south.

Now :

(i) Bring the north pole of a second magnet near the north pole of the hanging needle. What happens ?

(ii) Bring the north pole of the second magnet near the south pole of the hanging needle. What happens ?

(iii) Bring the south pole of the second magnet near the north pole of the hanging needle. What happens ?

(iv) Bring the south pole of the second magnet near the south pole of the hanging needle. What happens ?

You will observe that the north pole of a magnet will attract or pull the south pole of another magnet towards it. The south pole of a magnet will attract the north pole of another magnet. Therefore, unlike or different poles attract. The north pole of a magnet will repel or push the north pole of another magnet. Similarly, the south pole of a magnet will repel the south pole of another magnet. Therefore like poles repel. This is a basic property of magnetism which may be stated as follows :

'Like poles repel, unlike poles attract'.

The action of a magnet upon another magnet is known as *magnetic interaction.*

The magnetic interaction can be used to determine the pole of a magnet. Bring the end of a magnet to the north pole of a hanging magnet. If the north pole of the hanging magnet is attracted towards the end of the magnet, the end of the magnet is the south-pole while the other end is the north-pole.

7.5. Magnetic Field

A magnet exerts a force on magnetic substances placed near it. The force is the greatest at the poles of the magnet itself. The force is also felt outside the magnet. The region round the magnet in which the magnetic force can be felt by a magnetic substance is called the *magnetic field* of the magnet. You cannot see a magnetic field but you can see what the force in a magnetic field can do.

Activity 7.4.

(i) Sprinkle some iron filings on a white card-board. Move a bar magnet just below the board (Fig. 7.7). Do the iron filings move with the magnet ? If they do, the iron filings are in the field of the bar magnet.

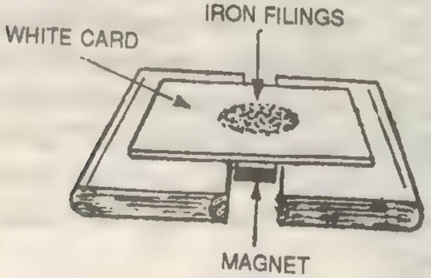


Fig. 7.7.

(ii) Move the magnet further away from the board. Do the iron filings move as the magnet is moved about ? If they do not, the iron fillings are not in the field of the bar magnet.

7.6. Simple Methods of Producing Magnets

We can make our own magnets. Let us find out how we can do this.

Activity 7.5

(i) *Making a magnet by induction.* Take a magnet, a large nail and some paper pins. Touch the pins with the iron nail. Does the iron nail attract the pins ?

Fig. 7.8.

Now place the magnet, the nail and the pins in a line. Move the pins closer to the nail. What happens to the pins ? Take the magnet away. Does the nail still attract the pins ? Does the nail still attract the pins a little while later ?

The nail becomes a magnet by induction.

(ii) *Making a magnet by stroking.* Take a magnet, a steel knitting needle and some

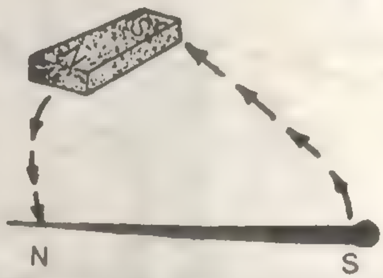


Fig. 7.9. Direction of movement.

pins. Put the knitting needle on a table and then stroke it with a magnet. Stroke the knitting needle in one direction, from one end of the needle to the other, using the same pole of the magnet all the time (Fig. 7.9). Do this about 30 times. Pick up some pins with it. Your knitting needle has now become a magnet.

Does the knitting needle still attract the pins a little while later ?

7.7. Types of Magnets

There are two kinds of magnets :

(i) Temporary magnets

(ii) Permanent magnets.

7.10. Temporary and Permanent magnets.

Temporary magnets are usually made of iron and are able to keep their magnetism for a short time only. Permanent magnets are usually made of steel and are able to keep their magnetism for a long time.

7.8. Magnetic Compasses

Finding your way in big city is easy because streets, buildings and roads differ so much that it is easy to give or follow directions. But it would be difficult to find your way through a thick forest. You would have still more difficulty on the ocean because there is almost nothing to guide you. Yet, you know that explorers can find directions in dense jungles, sailors and pilots cross the trackless oceans without difficulty. Do you know how they are guided in their directions. Sailors have used compasses for centuries to help them steer their ships in the right direction. Aeroplanes have compasses too. Mountaineers, hunters and scouts carry compasses and know how to use them.

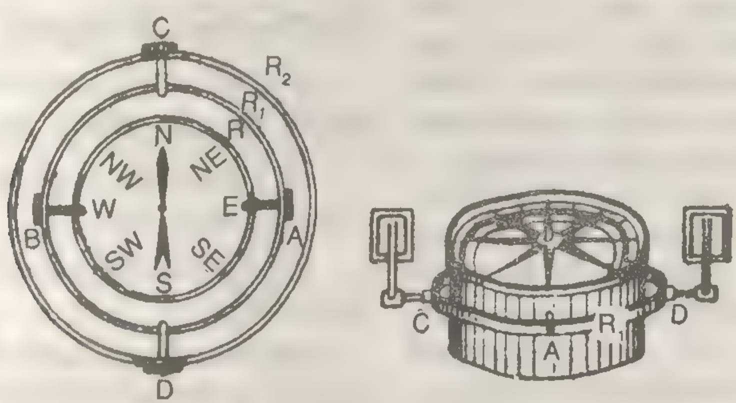


Fig. 7.11 Mariner's Compass

In a magnetic compass, the magnetic needle is supported in such a way that it can rotate freely. When the compass is placed at rest, the needle will come to rest in the north and south direction. The two ends of the needle are marked differently so that we can know which is the N-pole of the needle, and which is the S-pole. The compass is provided with a circular scale below the needle. The axis of the needle passes through the centre of this circular scale. The scale has all the cardinal points marked on it. All these components are enclosed in a case having a glass cover.

While adjusting the compass for correct setting, one should be careful to remove all iron and steel objects near the compass as their presence will affect the reading. Two compasses which are commonly used are the Pocket Compass and the Ship's Compass (Mariner's Compass) Fig. 7.11.

7.9. Earth's Magnetism

When a bar magnet is hung freely, it comes to rest in a north-south direction. Another bar magnet hung in the same way, some distance away, will also come to rest in the same direction as the first magnet. The reason the bar magnets come to rest, in a north-south direction is because of the earth's magnetism. There is a very large magnetic field all round the Earth. This magnetic field acts upon the magnet and brings it along the north-south direction. Fig. 7.12 gives schematic diagram of the magnetic field round the earth. The magnetic lines of force indicate that the magnetic fields seems to be produced by a huge magnet in the Earth, with its south-pole pointing towards the geographical north and its north-pole pointing towards the geographical south. Scientists are still not certain how the earth got its magnetism. Some way it might be due to deposits of magnetic materials.

Fig. 7.12. Magnetic field of the Earth.

The magnetic poles of the Earth are not at the same positions as the geographic north and south poles. They are at a short distance away from each other. Any place on Earth would have a geographic meridian and also a magnetic meridian.

7.10. The Care of Magnets

Magnets can lose their magnetism if you do not take proper care of them.

(i) You should not heat a magnet or place it near a fire.

(ii) You should not drop a magnet or knock it.

(iii) When you are not using magnets, you should protect them with magnetic keepers.

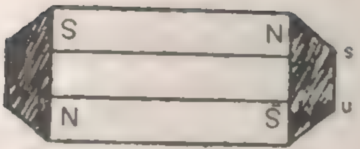


Fig. 7.13

A magnetic keeper is a piece of soft iron which is usually placed across the poles of a horse-shoe magnet. Bar magnet are kept in pairs with opposite poles side by side having a soft iron piece placed across the poles at each end when the magnets are not in use (Fig. 7.13). How will magnetic keepers keep the, magnetism intact ?

7.11. Some uses of a Magnet

(i) Boy scouts use a small compass during the field trips. It helps them to find the direction.

(ii) Some of the shopkeepers use a magnet to detect a base coin.

(iii) Magnets can be used in the construction of certain toys to give magic like effect.

(iv) A chart can be fixed to an iron sheet with the help of small magnets at the four corners.

7.12. Magnetic Field produced by Electric Current

Most of the everyday applications of electrical energy depend on the fact discovered in 1820 by the Danish Physicist, Oersted, that there is a magnetic field associated with electricity flowing in a wire.

Oersted's Experiment

Oersted discovered this magnetic effect of an electric current rather by accident. He set up a straight wire, running north and south, above a magnetic compass needle. When he switched on an electric current in the wire, the needle was deflected at right angles to the wire in a direction depending on which way the current was flowing (Fig. 7.14).

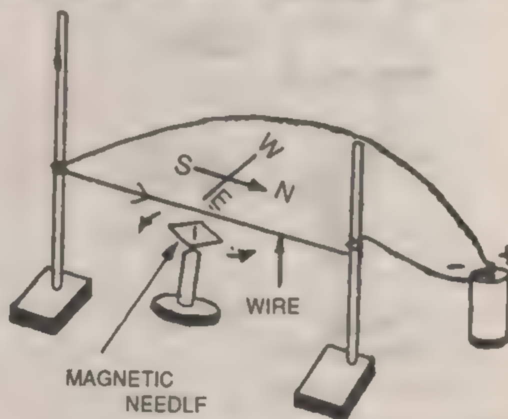


Fig. 7.14

With the current flowing from north to south, the N-pole of the needle was deflected towards the east, while a current from south to north caused a westerly deflection.

Placing the wire under a needle caused the deflection to be reversed in each case.

7.13 Magnetic Field of a Solenoid

A long coil is called a *Solenoid.* The magnetic field due to a current flowing in a solenoid is shown in Fig. 7.16

It is even more obvious here that the field is identical with that of a bar

magnet. Such a solenoid (when a current is flowing through it), if suspended freely, will set itself N and S like a compass needle. The ends of the current-bearing solenoid are attracted or repelled by a bar magnet.

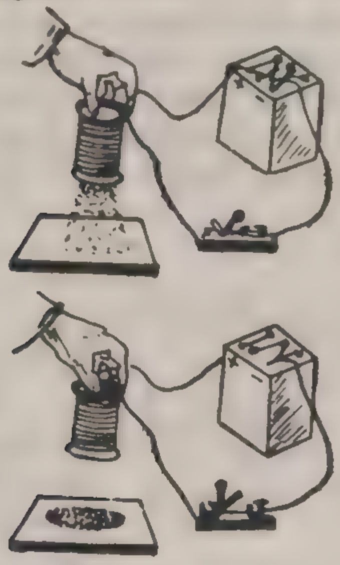


Fig. 7.15 (a) and (b)

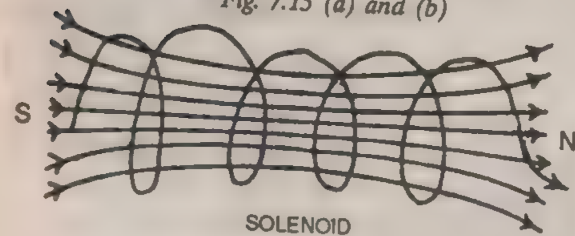


Fig. 7.16

An important difference between a current-bearing solenoid and a bar magnet is that the solenoid is hollow and has an intense magnetic field along its axis, while a magnet is solid. It should be noted that in Fig. 7.16 the lines of the force inside the solenoid run from the end of south polarity to the end of north polarity. The positive direction of the magnetic field inside a solenoid is from the south end to the north end.

Activity 7.6

Arrange the device as shown in Fig. 7.17.

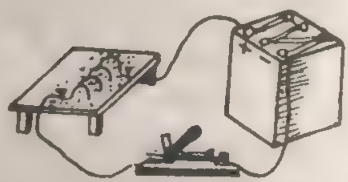


Fig. 7.17

Here the turns of the solenoid are passed through the top of the cardboard table.

Spread some iron filings on the cardboard. Connect the solenoid to a battery of dry cells and tap the table gently. What do you observe ? How do the iron filings arrange inside the solenoid ? What does the distribution of magnetic lines of force demonstrate ?

Determine the pole of the coil with the help of a magnetized needle. From which pole do the magnetic lines of force emerge ?

Magnetizing Action of a Solenoid

If a bar of iron bar is placed inside a solenoid carrying a strong current it becomes magnetized. The end of the bar at the end of north polarity of the solenoid acquires a North-pole and the other end a South-pole. This is a much quicker

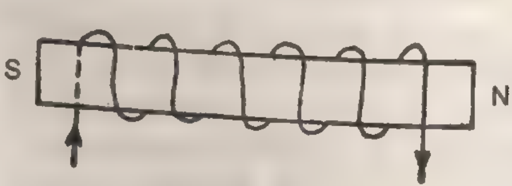


Fig. 7.18

and more effective method of magnetizing than stroking with a bar magnet. The direction of magnetization clearly depends on the direction of the current and the way the solenoid is wound (Fig. 7.18).

To sum up, the properties of a current carrying solenoid are :

(i) From outside it resembles a bar magnet.

(ii) From inside it has a strong magnetic field from south end to north end and hence it is valuable for magnetizing.

7.14. The Electromagnet

We have seen that a solenoid carrying a current behaves like a magnet. If a bar of iron is inserted in the solenoid the strength of the magnet is much increased, since the lines of force due to the magnetized iron are added to those due to the current in the solenoid. Such an arrangement (*i.e.,* a solenoid with an iron core) is called an *electromagnet.* It was invented by Sturgeon in 1825.

The strength of the magnet is proportional to the product of the strength of the current in amperes and the number of turns per centimetre. This product is often called the *ampere turns.* If many turns of wire are used, a weak current can produce as strong a magnet as a stronger current flowing through fewer turns.

When we compare the efficiency of steel and soft iron core in an electromagnet, we see that the field is stronger in the case of iron core. But steel retains a small amount of magnetism even when the current has eased to flow in the coil of the electromagnet, whereas in the case of soft iron core the magnetism disappears altogether as soon as the current ceases to flow in the coil of the electromagnet.

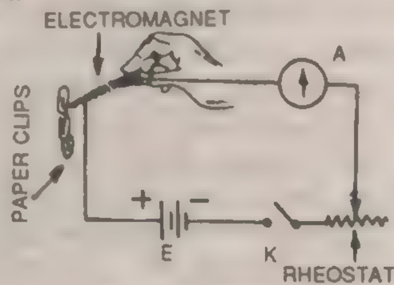


Fig. 7.19.

Make a coil of 30 turns of an insulated copper wire around a larger iron nail. This will be our electromagnet. Connect the ends of the electromagnet to a strong battery through an ammeter and a rheostat as shown in Fig. 7.19. Bring some paper clips near one end of the electromagnet. Switch on the current and adjust it to a strength of 1 ampere with the help of the rheostat. What do you observe ? Count the number of paper clips attracted to the end of the electromagnet.

Repeat the experiment with a coil of 60 turns of the same copper wire over the same nail. Adjust the current to 1 ampere and find how many of the clips are attracted this time ?

Do we conclude that the strength of the magnetic field of the electromagnet increases with the increase in the number of turns of the coil provided the current is kept constant ?

Now, repeat the experiment with an electromagnet of 30 turns. Adjust the strength of the current to 2 amperes. Find out the number of clips attracted to the electromagnet. What do we conclude ?

Use of the Electromagnet

Electromagnets have different shapes depending on their purpose. Fig. 7.20 shows a horse-shoe electromagnet holding a weight suspended from it. The horse-shoe electromagnet possesses more lifting force than a bar electromagnet because it attracts by its two poles simultaneously. Electromagnets are used for lifting heavy masses of iron and steel such as girders, scrap iron, or a cargo of nails, for separating iron and copper scrap, for picking out tins and iron from refuse in cities and hospitals, for drawing out pieces of iron lodged in the human eye, etc.

Electromagnets are also used when iron ore is to be separated from rocks in iron ore mines (Fig. 7.21).

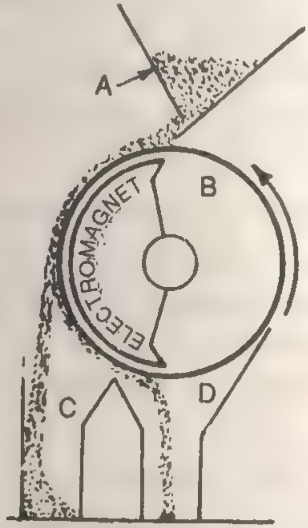


Fig. 7.21

Tramcars are fitted with slipper electromagnetic brake. The slipper consists of an iron block carried just above

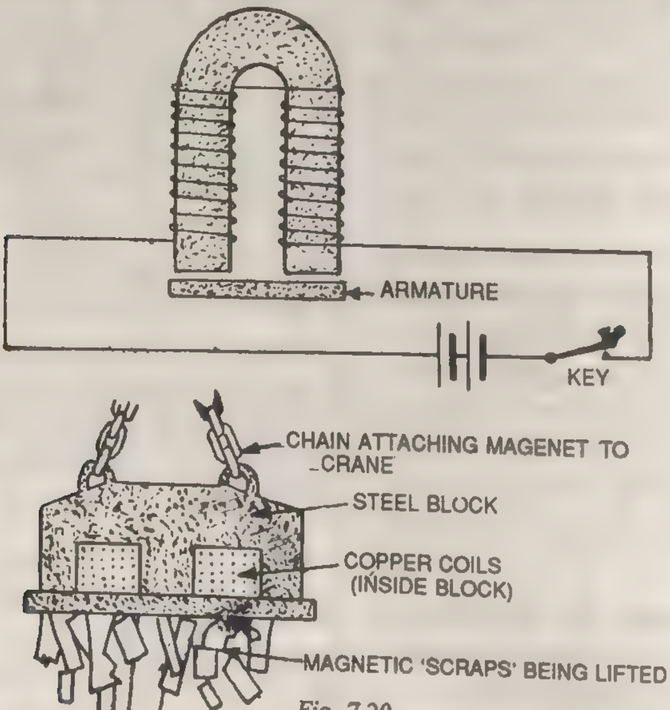


Fig. 7.20

the rail, the upper part of the block is wound as an electromagnet. When the current is switched on, the block is attracted to the rail and acts as very efficient brake.

Lamps are made with an electromagnet in the base which clings to iron when the lamp is switched on.

7.15. The Electric Bell

The ordinary household electric bell consists of an electromagnet, armature and spring similar to one we have just described, but it has in addition, a make and brake mechanism which causes the armature to be attracted and pulled back several times per second.

The electromagnet comprises of two coils wound on two arms of a soft-iron framework (Fig. 7.22). When the bell push B is pressed, the electromagnet attracts the armature A, to which is attached a small hammer, and the hammer hits the bell. The armature is also attached to a piece of springy steel, S, which makes contact with an adjustable screw at C. When the armature is attracted, the contact at C is broken, the circuit is no longer complete and the current ceases to flow. The springy steel S now pulls back the armature (which is no longer attracted by the electromagnet) and contact is made once more at C. The armature is again attracted by the electromagnet and thus 'A' begins to "tremble", causing the bell to be struck repeatedly.

The bell may be made to work most efficiently by adjusting the movable screw which makes contact at C.

There is usually a certain amount of sparking at C and the contact must be made of a metal which has a high melting point and which does not readily

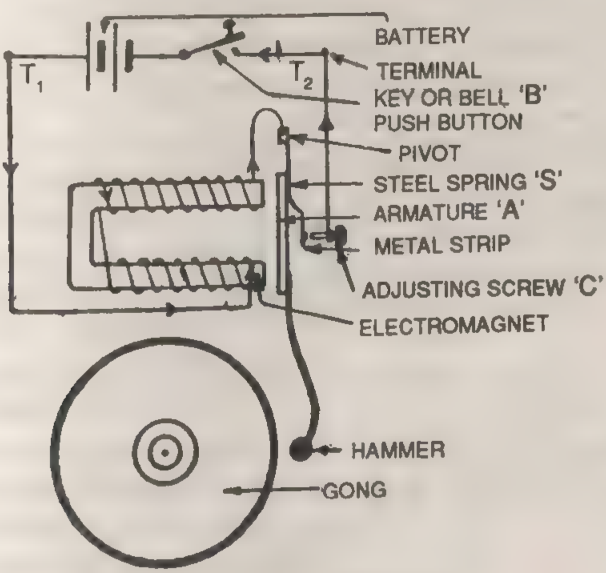


Fig. 7.22. Electric bell.

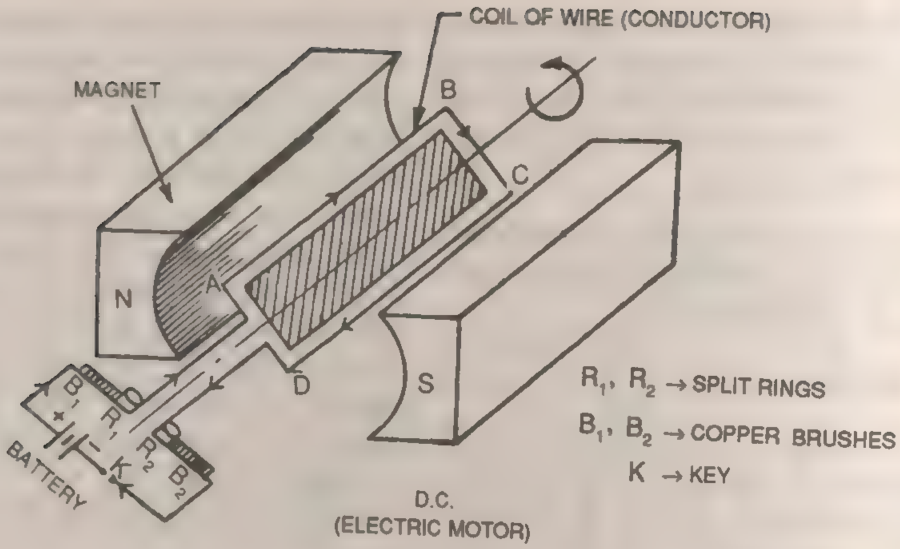


Fig. 7.23.

oxidise, in order to ensure a good electrical connection.

Electric bells are used in automatic signalling systems, in industry, railways, fire alarm, houses etc.

7.16. Current and Magnetic Field

It is found that if a conductor carrying current is placed in a magnetic field, it experiences a force and hence begins to move. This action is known as the *motor effect.* An electric motor performs the reverse function of a generator. *It converts the electrical energy into mechanical energy.*

There are different types of electric motors. Motors are made for working on different voltages. Some work only on A.C., some only on D.C. and some work on both A.C. and D.C.

Electric motors are used in the working of table fans and ceiling fans ; lathes ; drills and other machines in workshops. These are also used in blowers, electric pumps. air compressors, electric lifts, cinema projectors, electric trains and trams.

The principle of a D.C. motor is shown in Fig. 7.23. It consists of a coil ABCD wound on a soft iron core which is known as the armature. The ends of the coil are connected to the halves (R_1 and R_2) of ring. Two copper brushes B_1 and B_2 lightly press against the split rings R_1 and R_2. The armature is placed between the two poles N and S of a strong magnet. When the current is passed through the armature ABCD, a force will act on each length of the coil. The forces on two lengths are equal in magnitude and opposite in direction. They form a couple which rotate the coil.

SUMMARY

1. Any substance which like the load-stone, has two characteristics properties, attractive and directive is called a magnet.

2. Natural magnets like the loadstone are irregular in shape and have weak attractive and directive properties.

3. Artificial magnets are those magnets which can be made by artificial means.

4. A substance which is attracted by a magnet is called a magnetic substance. A substance which is not attracted by a magnet is called a non-magnetic substance.

5. A magnetic substance can be made into a magnet whereas a non-magnetic substance cannot be made into a magnet.

6. The two regions on a magnet which possess the maximum attractive power are called the poles of a magnet.

7. There is magnetic pole at each end of a magnet. There are always two magnetic poles on a magnet, no matter what its shape is.

8. Like poles repel, unlike poles attract.

9. The action of a magnet upon another magnet is known as magnetic interaction.

10. The region round a magnet within which its influence can be felt by a magnetic substance is called the magnetic field of the magnet. You cannot see a magnetic field but you can see what the force in a magnetic field can do.

11. A magnet has an attractive force, this magnetic force is able to pass through certain substances.

12. We can make our own magnets by induction and by stroking.

13. There are two kinds of magnets : Temporary magnets and Permanent magnets.

14. Magnets can lose their magnetism if you do not take proper care of them.

15. Sailors, pilots, explorers, hunters, scouts use compasses to find directions.

16. Earth behaves like a huge magnet. The exact cause of Earth's magnetism is still not known to the Scientists.

17. Magnetic field is associated with an electric current flowing in a wire.

18. There is a magnetic field in the space around a wire carrying an electric current just as there is a gravitational field in space around a body and an electric field in space around an electric charge.

19. A loop carrying current behaves like a very short flat magnet with a N-pole on one side and a S-pole on the other.

20. Solenoid is a long coil. The magnetic field due to current flowing in a solenoid is identical with that of a bar magnet but it has an intense magnetic field along its axis also.

21. Solenoid with an iron core is called an electromagnet. It produces a very strong magnetic field as long as electric current flows in it. The strength of the electromagnet is proportional to the product of the strength of the current in amperes and the number of turns per centimetre.

22. Electromagnets have different shapes and have varied practical applications.

23. The ordinary house-hold electrical bell consists of an electromagnet,armature and a spring in addition to a make and break mechanism. Electrical bells find many applications in our everyday life.

24. Electric motor converts electrical energy into mechanical energy.

QUESTIONS

1. A compass, whose needle will normally point to the magnetic north, is placed next to a magnet as shown in Fig. 7.24. Copy the diagram, showing the compass needle and the direction in which it will point.

Fig. 7.24.

2. Fig. 7.25 is a diagram of the magnetic field of a horse-shoe magnet. Mark its poles.

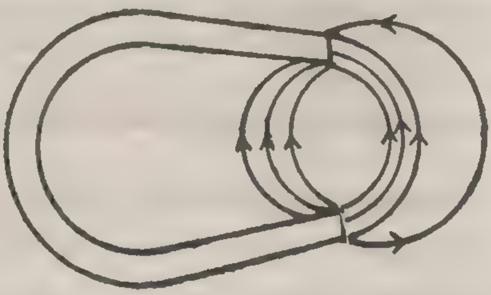


Fig. 7.25

3. Is the field shown in Fig. 7.26 stronger at A or at B ? What do the lines and arrows show ?

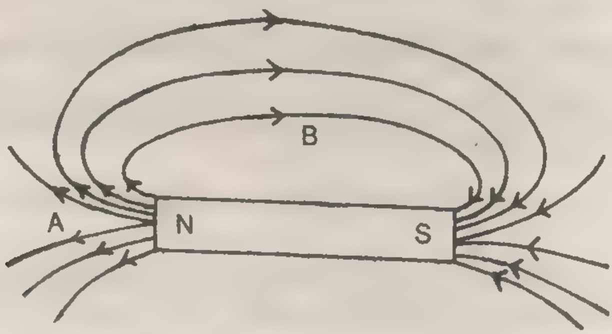


Fig. 7.26.

4. What is the difference between a natural magnet and an artificial magnet ? Mention examples of each.

5. What is the difference between a magnet, a magnetic substance and a non-magnetic substance ?

Classify the following under (a) Magnetic and (b) Non-Magnetic

Lead, aluminum, nickel, brass, copper, cobalt silver, iron, zinc, steel, sulphur and carbon.

6. How can you show that a magnet will act through non-magnetic substances provided they are not too thick but not through magnetic substances ?

7. Describe two ways of magnetising an iron knitting needle and three ways of demagnetising it.

8. State the law of magnetic attraction and repulsion.

Given a compass needle, show how you can use this law to differentiate between three identical iron rods, one of which is a magnet, the second a non-magnet but made of a magnetic substance and the third a non-magnetic substance.

In what other way can you differentiate between the three identical rods ?

9. What is a magnetic field ? Can it be seen ? Can it be detected ? Can a magnetic field be mapped out ?

10. What are magnetic poles ? Is magnetic pole a point ? Can a magnet have one pole only ?

11. Discuss the following statements :

The N-pole of a magnet is attracted by the N-pole on the Earth, from which we conclude that like poles attract.

12. Why is a horse-shoe magnet often supplied with a 'keeper' ?

13. A magnetised needle is floated on a dish filled with water. Will it drift northward ? Explain.

14. What is a loadstone ? How does the behaviour of a loadstone differ from that of an ordinary rock ?

15. What are the common uses of magnets ?

16. What is a compass needle ? Why does it point in the north-south direction ?

17. Complete the following sentences :

(i) A bar magnet has a .... at each of its ends.

(ii) Magnets are of different .... and ....

(iii) A piece of ..... can be easily .... by using a ....

(iv) ....during the day and ...... at night help us to get an idea of the directions.

(v) Our earth has some deposits of ...... materials due to which it behaves like a ....

(vi) ....Magnets are made of some powdered materials pressed together and brittle. These magnets are very ..... and are of different ....

(vii) Boy scouts use a small .... during their field trips. it helps them to find the ....

(viii) If both the ends of a permanent magnet attract an unknown piece of steel, it is ....

(ix) Any object which has power of attracting iron is called a ....

18. In Fig. 7.27 the compass needle B, east of the coil, points west. Which way does compass needle 'A' point ? Put in the correct needle direction in A.

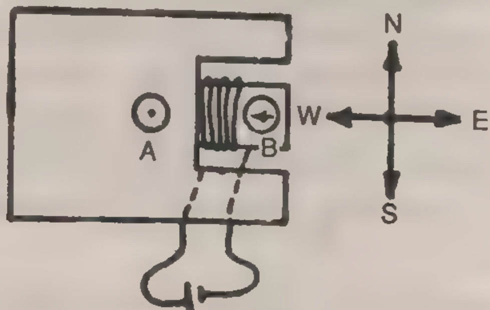


Fig. 7.27

If the current direction is reversed. Which way will A point ? Which way will 'B' point ?

19. In the apparatus shown in Fig. 7.28.

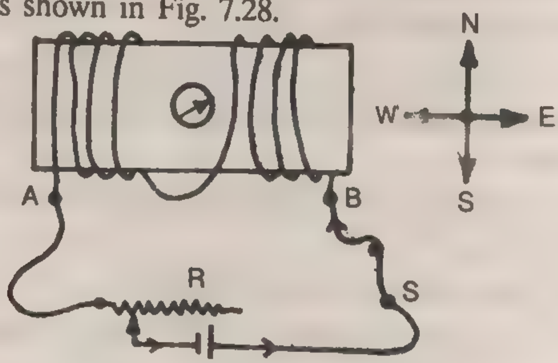


Fig. 7.28.

(i) What happens to the needle when the slider of the rheostat at R is moved to the right ?

(ii) What happens when the switch S is raised so as to stop the current ?

(iii) What happens when the battery is reversed ?

20. (i) Fig. 7.29 (A) shows a primitive form of electrical bell. What happens when the switch is closed and why ?

(ii) In Fig. 7.29 (B) some extra parts have been added as shown. What happens now when the switch is closed and why ?

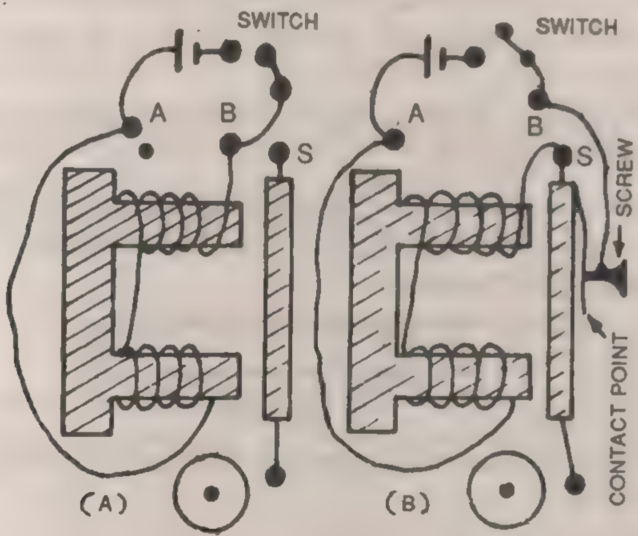


Fig. 7.29

21. If the direction of a current in a conductor is towards the reader but out of the pages, is the direction of the magnetic field : (choose one answer)

(i) along the conductor towards the reader ?

(ii) clockwise around the conductor ?

(iii) Counter-clockwise around the conductor ?

(iv) along the wire into the page ?

22. We can increase the lifting force of an electromagnet by :

(i) increasing the current ;

(ii) increasing the number of turns of wire ;

(iii) increasing the cross-sectional area of the core ;

(iv) making the core of glass instead of soft-iron.

Choose the answer from above which is not correct.

23. Two electromagnets, A and B are identical, except that A has 100 turns of wire and operates on a current of 50 amperes while B has 200 turns of wire and operates on 20 amperes. Which is the stronger magnet, A or B ? Why ?

24. A straight conductor is placed parallel to the magnetic field of a magnet. Will it move in any direction when a current is passed on it ? Give your reasons.

25. (a) In-what direction will the N-pole of a compass needle be deflected when held over a current flowing from north to south?

(b) A compass needle is held below a wire running north and south and the N-pole of the needle is deflected to the east. What is the direction of the current in the wire ?

26. What is the cause of the increase in the magnetic field when a bar of soft iron is placed inside a solenoid ?

27. A circular coil of wire, free to move, rests near one end of a bar magnet as shown in Fig. 7.30. What will happen if a current is made to flow in the coil in the direction shown ? Give reasons.

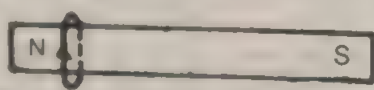


Fig. 7.30

28. Describe Oersted's Experiment and indicate the conclusion that he drew from this experiment.

29. (i) What is a magnetic field ?

(ii) What is a Solenoid ? Compare the magnetic field of a bar magnet with that of a Solenoid.

30. What is an electromagnet ? Discuss some of its practical uses in daily life.

31. Give the construction, working and use of an Electrical bell.

32. Write a short note on Electromagnet.

33. (a) What is motor effect ?

(b) What is an electric motor ? Mention some of its uses.

(c) How does an electric motor differ from a generator ?

34. Complete the following sentences :

(i) .... in a wire affects a magnetic compass.

(ii) In order to step down 220 V mains current to 6 V we use a ....

(iii) In an electric motor .... energy changes into ...... energy.

(iv) ....passing through an insulated copper wire would round a piece of iron makes it a .... This .... worked as long as the .... passes.

(v) A coil of copper wire carrying ....rotates when suspended freely in a ....

CHAPTER 8

THE MICROBIAL WORLD

8.1. What are Micro-organisms ?

The word *micro* means very small. Micro-organisms are very small organisms and difficult to be seen by naked eye. They can only be seen with the help of a microscope.

Micro-organisms include virus, bacteria, algae, fungi and protozoa.

Some of the micro-organisms are :

(i) Autotrophic, Saprophytic ; others are

(ii) Parasitic and yet there are others, which are

(iii) Symbiotic.

Virus

These organisms are a link between living and non-living world.

These *viruses* can be preserved as *crystals of salt* and *sugar.* When viruses come in contact with living cells, they start multiplying and show some characters of *living organisms.* These organisms are visible only under very high magnifications such as under an electron microscope. Because of their minute size, they are able to pass through the cell membranes. Viruses have only one type of nucleic acids either DNA or RNA. They only grow and multiply in the living tissues ; outside a living tissue they behave like non-living matter. All viruses are parasitic and cause deadly diseases like smallpox, polio and rabies. Common diseases like influenza and cold are also caused by viruses.

Bacteria

These are minute, single-celled plants that are too small to be seen with the unaided eye. Most of the bacteria lack chlorophyll and so are not able to make their own food. They have, therefore, to depend on other sources for their food. It has been observed that there are some bacteria which are photosynthetic in nature. The non-photosynthetic bacteria are either '*saprophytic*' deriving food from dead and decaying organic matter, or parasitic, obtaining their food from the tissues of other living organisms.

Fungi

The term 'Fungi' is commonly used to refer to those groups of plants which

Fig. 8.1 Mushroom

lack chlorophyll and which pass a heterotrophic mode of nutrition.

Fungi like yeast are unicellular and some other fungi like Mucor, Mushroom, Penicillium and Streptomyces are multicellular types.

Protozoans :

The protozoans like Amoeba, Plasmodium etc. are unicellular micro-organisms. They are the kind of animals. They have tremendous role to play in the activity of human life.

8.2 Microbes and Diseases

Quite a few of the microbes cause diseases to humans, animals and plants.

We have made a mention of some of these diseases in your previous book. Here, we shall talk about some diseases caused by micro-organisms.

Most of the diseases caused by microorganisms are either by contact, or may be transmitted through air, food, water or soil. Therefore, the diseases are called *communicable* or *infectious*.

Diseases caused by Bacteria

In Animals

(1) **Anthrax.** It is a disease found in cattle. It results in swelling of the body as well as neck and reduces in milk production.

(2) **Tuberculosis.** This bacterial disease of cattle can pass to man through milk.

The cattle suffers from fever and dry husky cough.

In Man

(1) **Pneumonia.** Causative agent is a bacterium (*Pneumococcus*). They usually infect the respiration passages and the lungs (Fig 8.2)

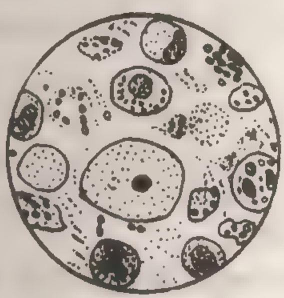


Fig. 8.2 Pneumonia.

Symptoms are the sudden onset of chill and rise in temperature. The respiratory passages get blocked, thereby making breathing difficult.

Transmission is through droplets.

This can be prevented by isolation of the patient, and avoiding contact with the patient. The clothing of the patient also should be kept separate and must be disinfected before washing and use.

(2) **Diphtheria.** Causative agent is the straight or slightly curved rodshaped bacterium (Fig. 8.3). This disease is highly infectious and is characterized by the formations of patches of false membranes in the throat and wind pipe, causing obstruction of the respiratory passage resulting in death by suffocation. The toxins produced by these germs may even reach the nervous system and other parts of the body and damage them.

Children are highly prone to this disease. Transmission is through droplets

excluded through the nose and mouth while coughing, sneezing or talking.

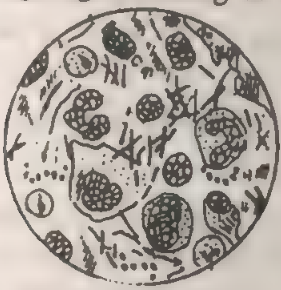


Fig. 8.3 Germs Causing Diphtheria

Prevention can be done through immunization isolation of the patient and keeping his clothings and other articles separate and sterilizing these from time to time.

(3) **Cholera.** Causative agent is the bacterium (*vibrio cholera*). This bacterium has a single flagellum (Fig. 8.4).

Fig. 8.4 Germs of Cholera

This disease affects the digestive system resulting in diarrhoea and continuous vomiting. This may lead to death by dehydration as there is a continuous loss of body fluid.

These germs are transmitted through food and water. Flies also play an important part in its transmission.

This disease can be prevented by immunization, isolation of the patient and by drinking boiled water and well-cooked food.

Fig. 8.5 Flagella causes Typhoid

(4) **Typhoid** Causative agent is the bacterium having numerous flagella (Fig. 8.5).

The symptoms of this disease are continuous fever, inflammation of the intestine and also ulceration of the digestive tract, enlargement of spleen and appearance of reddish eruptions on the abdomen.

Transmission of this disease is through food and water. Prevention is by artificial immunization by control of flies, isolation of the patient and using boiled water and eating well-cooked food.

In Plants

(1) **Bacterial Blight of Rice.** Here the leaves of rice crop plant start drying. The whole rice field gives a burnt appearance. This results in the loss of grain yield production.

Diseases caused by Virus

In Animals

Foot and Mouth disease. The disease is caused in animals of all age groups. Here, the erruptions are seen in the mouth and on the feet. With the result, the efficiency of animal decreases.

In Human

(1) **Common Cold.** The causative agent of this disease is a virus. Children are more prone to this disease. This disease affects the respiratory passages, especially the nasal epithelium resulting in the flow of mucus, headache and even slight temperature.

This disease is not very dangerous, but lowers the resistance of the body to germs of other diseases such as pneumonia and bronchitis.

(2) **Influenza.** The causative agent of this disease is a spherical virus. This is highly contagious. The symptoms are sudden onset of fever, also accompanied by body aches.

The mode of transmission is through droplets again, and the virus enters the body of a healthy person through the respiratory passages.

(3) **Measles.** Here, a person suffers from fever, dry cough and running nose; eyes become sensitive to light; respiratory tract becomes affected, and rashes appear on the face, neck and trunk.

(4) **Polio.** The nervous system of the body gets affected. There is a paralysis (non-functioning) of the voluntary muscles of the person.

(5) **Chicken Pox.** It passes from one person to another through contact with clothings, bed and other articles used by patient. Skin erruptions appear, first. In serve cases, whole body is full of erruptions.

In Plants

(1) **Leaf Mosaic.** The plants affected by this disease show patchy leaves. The yield of plant is reduced, tremendously.

Diseases caused by Protozoans.

In Man

(1) **Malaria.** This is again caused by a protozoan called Plasmodium (Fig. 8.6) which lives as a parasite within the red blood cells of the human body.

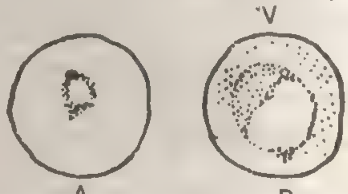


Fig. 8.6 Plasmodium causes Malaria.

The symptoms of this disease are chill (shivering) and a rise in the temperature ; this is followed by the fall in temperature by sweating. This is repeated every 48 to 72 hours. Severe attack of malaria may even destroy the tissues of spleen and liver.

(2) **Amoebic dysentry or Amoebiasis.** *Entamoeba* causes the disease. It passes on, to human beings through infected food and water. The symptoms of the disease are frequent loose stools or diarrhoea, with pain in the abdomen. The blood stained mucous passes along with stool.

Diseases caused by Fungi.

In Man:

Ring Worm. Ringworms appear on the head, foot and hand. Ring worms show round patches and spreads on the skin. They too spread by contact.

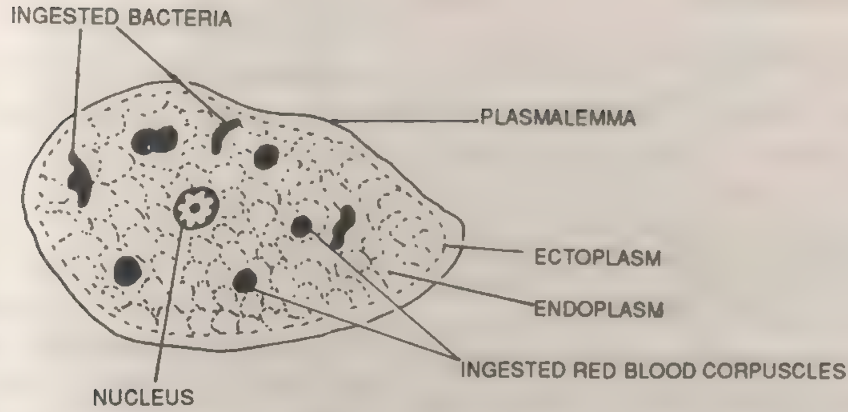


Fig. 8.7 Entamoeba

In Plants

Wheat Rust. It is a very common disease of the wheat plant. The disease causes lot of damages to the crop every year. On the leaves and stem of the wheat plant, there appear rust colour patches called *wheat rust*.

8.3 Transmission of the Disease

As said earlier, the diseases caused by microbes are *communicable* and transmitted from person to person through contaminated air, water, food, soil, organism etc.

Diseases caused by air are *air-borne* diseases such as influenza, common cold etc.

Diseases transmitted through water are *water-borne,* through food are *food-borne* and through soil are *soil-borne.*

Similarly, there are diseases, transmitted from one person to another through organisms such as animals. Such carrier animals are called *vectors.*

Malaria is transmitted by the female anopheless mosquitoes (Fig. 8.8). Within the body of the mosquito this parasite undergoes a developmental cycle.

Fig. 8.8 Anopheles.

Mosquito *(Anopheles)* is a vector for causing *malaria* caused by protozoan *(Plasmodium)*.

Mosquito *(Culex)* is a vector for causing *Filariasis* caused by *Filarial worm.*

8.4. Controlling the Micro-organisms

Various scientists like Leeuwenhoek, Spallanzani, Louis Pasteur and Sir Ronald Ross proved with their elegant experiment that microbes are responsible for causing various drastic diseases to human beings and damage to our foodstuffs.

1. By Immunization

Prevention against Harmful Microbes

It has been seen that the body of a human being can defend itself against bacteria. The white cells of the blood and lymph feed on bacteria and the blood can produce substance called *antibodies* which can kill the bacteria.

After a person-recovers from a bacterial diseases, his body will sometimes contain a reserve of antibodies which will protect him from that disease for some time. This protection is called *immunity*.

This *measure* was studied by British Physician *Edward Jenner.*

These days to get rid of the disease we adopt a measure called *artificial immunisation*. This is done by injecting a person with a small dose, called *vaccine,* which makes the body produce antibodies against a particular disease.

If the doses of these vaccinations are taken as directed above one can get life long immunity against many of such diseases.

2. By Personal Hygiene. The best protection against disease is to keep a sound

Vaccination Schedule for Children

Name of Vaccine	Against the Disease	Primary Vaccination	Revaccination
1., B.C.G.	Tuberculosis.	After 2 months of birth.	Not needed.
2. D.P.T.	Diphtheria, Whoeping, cough and Tetanus.	Start at 2 months time, such vaccinations at 6-8 weeks interval.	At the age of 1½ years. Then 4½ years (Diphtheria and Tetanus) Tetanus repeated at 10 years and after 10 yrs.
3. Typhoid Vaccine.	Typhoid.	Start at 2 years, 2 doses at 3 to 6 weeks interval.	After every 2 years.
4. Polio-Oral drops.	Polio	Start at 2 months of age. Give 5 doses at 4 weeks interval.	After age 1½, 3½ and 4½ of years. Polio drops.

health. A person, who is well fed, *clean*, and not tired, will usually resist infection better than one, who already suffers from a number of minor complaints. Personal hygiene is the practice of maintaining good health. It involves the following.

1. **Hygiene of hands and skin.** Keep the skin clean. Always wash hands after doing any kind of work/sanitation work. One must take precaution to wash hands before and after eating food. We are continuously handling pleasant and unpleasant things, perspiring etc.; therefore, there is every possibility for the microbes to get chance to multiply and infect the body, in general. Cleanliness of the hands and skin must be kept in mind.

2. **Hygiene of eyes and ears.** Keep your eyes and ears clean. Eyes can be kept hygienic by washing with fresh water and using the towel thereafter. Similarly, avoid coming in, of water in the ears during bath.

3. **By Hygiene of Food.** Cleanliness of the food is very important. Wash off the fruits and vegetables, before eating. Keep the surroundings, where food is cooked or eaten, clean. Never, leave the food uncovered. Never, eat exposed food from the road sides. Flies etc. infect food with germs.

4. **By Hygiene of the toilets and bathrooms.** These places are used very regularly. Infection of diseases can spread from dirty bathrooms and toilets. Never, allow water to get accumulate in the toilets.

5. **Proper disposal of garbage, refuse etc.** The garbage and refuse from the houses need to be disposed in proper dustbins, and dumping places. One should never dump garbage in the open. This is a very suitable place for the bacteria to grow and multiply. From here, it becomes very easy for houseflies to carry the infection.

6. **Control of Vectors.** You all know, vector acts as an agent to transfer a disease causing microbes from diseased person to another person. You have learnt about mosquitoes acting as vector.

Houseflies too act as vectors. To prevent these vectors, spray of insecticides is very essential. Insecticides like DDT, BHC etc. can destroy the places where these vectors can reproduce and lay eggs.

7. **Control of Plant diseases.** (i) To control the plant diseases, fungicides (to kill fungi causing disease) like bordeaux mixture, compounds of copper and insecticides can be used on the standing crops, so as to stop infection.

(ii) Burning of the plant debris, and diseased plants : Soil-borne and saprophytic diseases borne on plant debris are killed by this method.

8.5. Useful Activities of Microbes

Microbes are not only harmful and disease causing organisms. In contrast, they have lots of uses for the human beings.

Though some of the *bacteria* are harmful causing a number of diseases, there are many varieties of bacteria which are beneficial to man.

Uses of Bacteria

1. Bacteria decompose excretory products and the remains of plants and animals into simple substances, thus, clearing the earth of its organic debris by putrefaction and decay. Putrefaction is the incomplete break down of the organic matter by the anaerobes resulting in the formation of substances with offensive odorous. Decay is the complete decomposition by the aerobes without release of any offensive smelling gases.

2. 95% of the carbon dioxide, which the plants use for their photosynthetic activities, comes from the various activities of bacteria.

3. Some bacteria help in the maintenance of the soil fertility. They are the ammonifying bacteria which convert the remains of the dead plants and animals into ammonia which is transformed into ammonium compounds. The nitrite bacteria convert these ammonium compounds into nitrites. The nitrate bacteria convert the nitrites into nitrates. These nitrates make the soil fertile, since the green plants can make use of the nitrogen more effectively only in this form. Certain bacteria such as *Rhizobium* living in the root nodules of the leguminous plants are able to fix free nitrogen of the atmosphere into nitrates.

4. The digestive tracts of the ruminating animals (cow, sheep, etc.) contain a large number of certain bacteria which help in the digestion of cellulose of the plant cells into simple sugars. A similar situation also occurs in the white ants which are able to eat and digest wood due to the presence of cellulose breaking bacteria present in their gut.

5. The bacteria present in the human intestine also make vitamins available to the host.

6. The sulphur bacteria convert hydrogen sulphide, a product of protein decay, into sulphuric acid. This gets transformed into sulphates, which are very essential for plant growth.

7. The production of vinegar, curd and cheese ; curing of tea, coffee and cocoa ; the tanning of leather and separation of fibres from the fibre plants such as flax, hemp and jute – all of these involve bacterial activity.

8. Some of the industrial products such as lactic acid, citric acid, vitamins, acetone and alcohols are obtained from bacterial activity.

Nitrogen fixation. In this process, the atmospheric nitrogen chemically combines with the other elements to form other nitrogen compounds that can be used by the plants. During nitrogen fixation, the nitrogen from the non-living world is introduced into the living system.

Fungi are of great economic importance to mankind.

Some Fungi like *Mushrooms* are edible. Some of them are extremely posionous.

Others like *Penicillium* is used in obtaining a very important antibiotic, Penicillin, for curing many diseases.

Some of the important antibiotics are :

(a) Penicillin,
(b) Streptomycin,
(c) Chloromycetin,
(d) Terramycin,
(e) Tetracyclin, etc.

We have antibiotics producing facilities in India at Rishikesh (U.P.) and Pimpri (Maharashtra).

Yeast

Yeast is an important fungus used in the manufacture of bread, alcohol and many other products. These are also non-green and non-flowering plants but having only one cell. They are very minute and can be seen only under the microscope. They are widely distributed, in the soil, air, in fruits and in food-stuffs containing sugar. Yeast, carries on fermentation, that is incomplete oxidation of sugars.

8.6. Storage and Preservation Prevents Microbial Damage

The microbes (bacteria, virus, fungi) cause damage not only to the standing crop or animals or human beings, but, they do cause tremendous loss to food, stored grains, leather goods, furniture and fabrics etc. Proper care should be taken to keep these useful products and materials safe from the attack of microbes.

Activity

Take a piece of bread, soak it partly with water, cover it and place it in a dark corner for two or three days.

Uncover the piece of bread and what do you see ?

You see a fluffy white growth with small black dots.

This is attacked by a fungus called *bread mould (Rhizopus)*.

Make sure that the leather goods, fabrics etc., when are stored, are dry and properly kept with some *disinfectant*.

Your furniture etc. needs to be treated with chemicals, painted, polished. So that microbes are unable to attack them. Your foods, fruits vegetables etc. are to be properly stored. These days, people use refrigerators, for storing of fruits, vegetables and left over food.

Left over food should never be kept carelessly. Conversely, if it is eaten, it may cause food poisoning called *Botulism*.

This is, again, due to the action of certain types of bacteria, of infected persons.

Bacteria and other microbes can be killed by the following ways :

(a) by preserving food by canning.
(b) by using antiseptics (used by Lord Lister) like Listerine Dettol, Carbonic acid, etc.
(c) pasteurisation of Milk (used by Louis Pasteur) *i.e.*, heating milk at 63°C for 30 minutes.
(d) boiling and filtering of drinking water.

We have talked about various ways of preserving food to keep it safe in your previous class (food, health and diseases).

SUMMARY

1. Micro-organisms are too small to be seen by a naked eye.

2. Virus, bacteria, fungi and protozoans are some of the microbes.

3. Microbes cause many kinds of diseases in animals, plants and human beings.

4. Diseases caused are communicable, which may be transmitted through food, water, soil or may be some microbe carrying organispn called, *Vectors*

5. Microbes causig diseases and damages need to be controlled.

(i) By Immunization
(ii) By Personal hygiene
(iii) By hygiene of food.
(iv) By hygiene of toilets and bathrooms
(v) By proper disposal of garbage and refuse.
(vi) By control of vectors.
(vii) By using fungicides and pesticides.

6. Microbes not only cause harm, but, they are very useful to plants, animals and human beings for performing useful activities.

7. Proper storage and preservation of materials, food products etc. prevent damages caused by microbes.

QUESTIONS

1. There is a list of diseases given below. Write in front of each whether it is caused by viruses, bacteria or any other microbe :

1. Typhoid. ....
2. Tuberculosis. ....
3. Chicken-pox. ....
4. Mumps. ....
5. Common cold. ....
6. Amoebic dysentery. ....
7. Malaria. ....
8. Tetanus. ....
9. Cholera. ....
10. Influenza. ....
11. Anthrax. ....
12. Yellow spots on the leaves. ....
13. Wheat rust. ....
14. Potato Masaic. ....

2. Write, what do you know about the following :

(i) Fungi.

(ii) Virus.

(iii) Protozoans

(iv) Bacteria.

3. Make a list of diseases that occur most commonly in your country, state, city. Give reasons for the spread of those diseases.

4. Define the following :

(i) Vector.

(ii) Pasteurization.

(iii) Immunization.

5. Make a list of useful, activities of :

(i) Bacteria

(ii) Yeast

(iii) Fungi.

6. Write short note on :

(i) Nitrogen fixation.

(ii) Control of spread of microbes.

7. Name the fungicides, pesticides you use often.

8. Write the symptoms of the following diseases :

1. Measles
2. Influenza.
3. Amoebic dysentery
4. Malaria
5. Chicken pox.

9. Write the ways, you store your food to keep it safe from microbes.

10. Make a list of vaccines you have taken along with the names of diseases :

11. What are the following famous for :

(i) Edward Jenner.

(ii) Louis Pasteur.

12. Write an explanation on 'Hygiene and the prevention of harmful microbes'.

ACTIVITIES

1. Write a place where edible mushrooms are cultured.
2. Make a chart of Immunization Table for your class.
3. Make a chart of different vectors and the spread of diseases.
4. Ask your teacher to show you some microbes like
   - (i) Curd forming bacteria.
   - (ii) Bread mould.

They can be seen under the microscope.

CHAPTER 9

ELECTRICAL CURRENT

9.1 What is an Electric Current ?

We have learnt about the transfer of charge, when two points at different electrical potentials are joined by a conductor, electrons flow along the conductor, from the point at the lower potential to the point at the higher potential (positive charge flows from the point at the higher potential to the other at the lower potential) until the potential at both the points becomes the same.

Such a flow of electric charge is called an electric current.

Thus, an electric current flows when there is an *electric potential difference.*

To keep an electric current flowing through a conductor, it is obviously necessary *to maintain the potential difference between its ends,* that is, to maintain a difference in electrical energy levels between the ends. This of course, requires consumption of some other form of energy. Taking again the hydrostatic analogy if a continuous current of water is to be obtained between two vessels, their level difference must be maintained by pumping back water from the vessel in which it is at a lower level to the one in which its level is higher, at the same rate at which it flows from the latter to the former. And this obviously entails an expenditure of energy (mechanical). So also, if a continuous flow of electric current is to be maintained between the two end points of a conductor some device must be found to transfer charge or electricity from the end point of the conductor at the lower potential to the other end at the higher potential, at the same rate at which it flows from the latter to the former.

9.2. Potential Difference—Positive and Negative Potential

You have already learnt in the previous class that the electric current is similar in may ways to the circulation of water through a closed system of pipes under the action of a pump (Fig. 9.1).

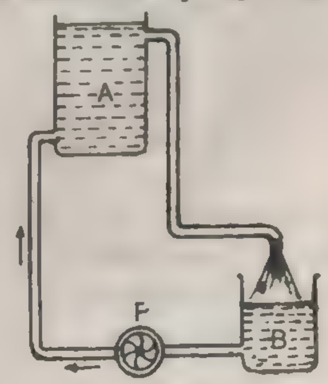


Fig. 9.1

When the pump is operating, it produces pressure differences between the various parts of the system and the water flows from reigns of high pressure to regions of low pressure.

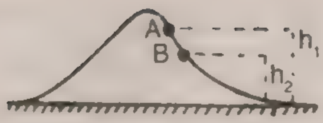


Fig. 9.2

Again when you release an object from a height, it always falls downwards. When a body at A is allowed to slide freely along the slope (Fig. 9.2) it will move towards B and not towards any point at height above A. In other words, it will move from a higher gravitational potential to a lower gravitational potential.

The flow of charge or motion of electrons round an electric circuit is similarly produced by differences in electrical pressure produced by the battery. Such a difference in electrical pressure is called *potential difference*. In order that electric current may pass from one point of the circuit to another, the battery or other sources must maintain a potential difference between the two points.

Energy is required to keep the current moving around the circuit. The energy, of course, comes from the battery.

The potential difference between any two points is measured in units called *Volts* and the charge is measured in units called *Coulomb*.

The potential difference between two points is 1 *Volt* when the source supplies 1 *Joule* of energy to pass 1 *Coulomb* of charge between them

$\therefore$ 1 Volt = 1 Joule/Coulomb

The energy acquired by an electron when it falls through a potential difference of 1 volt is called an *electron volt (eV)*, a term widely used in atomic physics for expressing energy. Similarly, there are units such as *kilo electron volt (keV)*, and *Mega electron Volt (MeV)*

Just as the height of a place is measured with respect to sea level which is taken as zero or a standard level (as its capacity for water is so huge that any addition or removal of a small quantity of water does not affect its level appreciably) the potential of a conductor is measured with respect to that of the earth which is taken to *zero potential*. Earth is a good conductor of electricity and has a huge capacity for electric charge and any addition or removal of a small charge would not alter its potential appreciably.

The potential of a *positively charged* body is *higher* than the potential of the earth and the potential of a *negatively charged* body is *lower* than that of the earth. Thus a positively charged conductor has a *positive potential* as a positive charge flows from it to the earth and the electron flow will be from the earth to the conductor. A negatively charged conductor has a *negative potential* as the positive charge flows from the earth to the conductor. (The electron flow would be from the conductor to the earth). An earth connected conductor has *zero potential.*

We know that a dry cell is a simple source of electric current. A dry cell, when in use, converts the chemical energy stored in it to electrical energy. *The chemicals present in the cell build up an electrical*

potential difference between its terminals. It is this potential difference which is responsible for the flow of free electrons. Thus, an electric current flows through the circuit across the two terminals of the cell.

9.3. Sources of Electric Current

(1) Simple Voltaic Cell.

Luigi Galvani (1737-1798), a professor of Anatomy at the University of Bologna in Italy, made a discovery which led to the development of the first primary cell. He observed that frog legs, freshly dissected and suspended on copper hooks twitched when touched with an iron railing just below the legs. Galvani believed that the twitching was due to 'animal electricity' in the frog's leg.

Volta, who was a professor of Physics at the University of Pavia at that time investigated Galvani's observation. He discovered the correct explanation for the strange behaviour of the frog's legs : two dissimilar metals immersed in a conducting fluid cause a chemical reaction capable of producing an electric current. As a consequence of his investigations, Volta invented the first primary cell, now called the *Simple Voltaic Cell.*

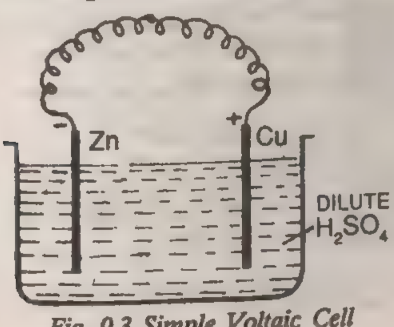


Fig. 9.3 Simple Voltaic Cell

The cell consists of a glass vessel containing a zinc plate and a copper plate placed in dilute sulphuric acid (H_2SO_4). The two plates are called *electrodes* and the liquid in which they are placed is known as *electrolyte*.

There is no chemical action between copper and dilute sulphuric acid. If we now connect the two plates by a piece of copper wire through a small torch bulb (Fig. 9.3), the bulb begins to glow. This shows that an electric current is flowing through the bulb from the cell. At the same time bubbles of hydrogen gas are seen to collect near the copper plate, showing that a chemical action is taking place. Interacting with the acid, the zinc plate becomes more negatively charged than the copper plate. An electric field is set up around the charged plates which sets up and maintains an electric potential difference between the plates and hence electrons begin to move from the zinc plate at which is a lower potential to the copper plate which is at a higher potential through the wire connecting them. Positive electricity flows from the copper plate to the zinc plate through the copper wire outside the cell. The copper plate from which the current starts is called the *positive pole* and the zinc plate through which the current enters the cell is called the *negative pole* of the cell. The direction of the current in the outer circuit is from the positive pole to the negative pole (conventional current) *i.e.,* from copper to zinc, and within the cell the direction is from zinc to copper. The true flow of an electric current

consists of the movement of electrons in the opposite direction (electron current) *i.e.*, from zinc to copper (See Fig. 9.3).

The source of the energy of the cell is the action of the sulphuric acid on zinc which is gradually consumed.

The zinc may be regarded as the fuel of the cell just as coal and petrol are consumed in railway and car engines.

The Dry Cell (*Torch light*)

The dry cell used in torch light is the only primary cell in common use. It is in fact a Leclanche cell in its miniature form (Fig. 9.4.).

The cathode (negative electrode) is a zinc container and the positive electrode a carbon rod. The carbon rod is surrounded by a mixture of manganese dioxide (the depolariser) and powdered carbon in a muslin bag. The electrolyte in the dry cell is a moist paste of ammonium chloride containing some zinc chloride, saw dust and plaster of Paris.

The zinc container is placed in a leak proof cover and the top is sealed with tar.

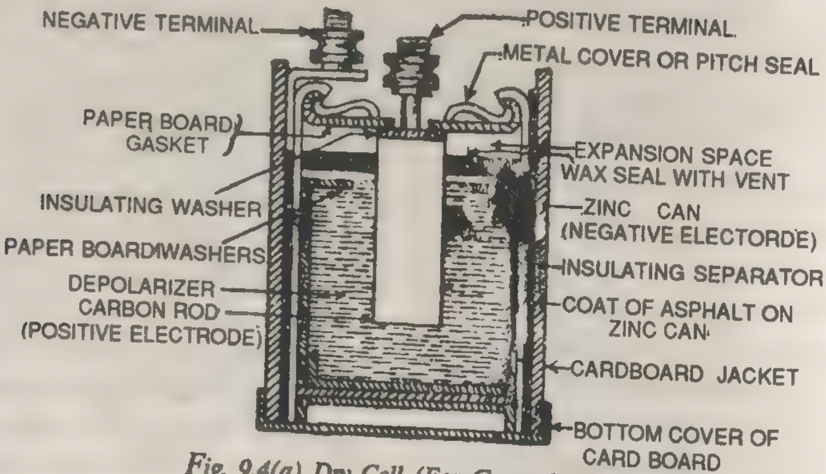


Fig. 9.4(a) Dry Cell (For General Use)

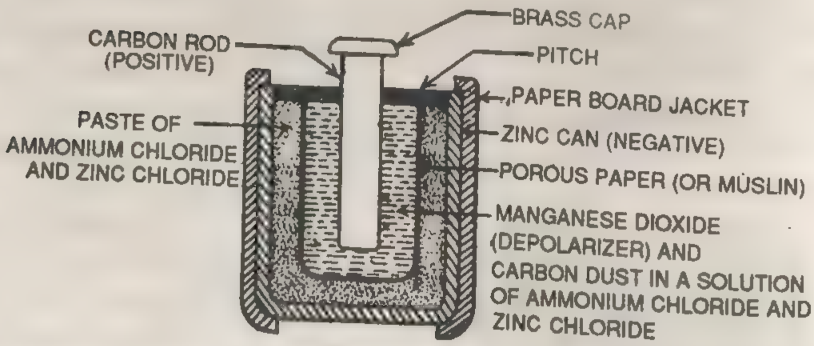


Fig. 9.4 (b) Dry cell for Torch

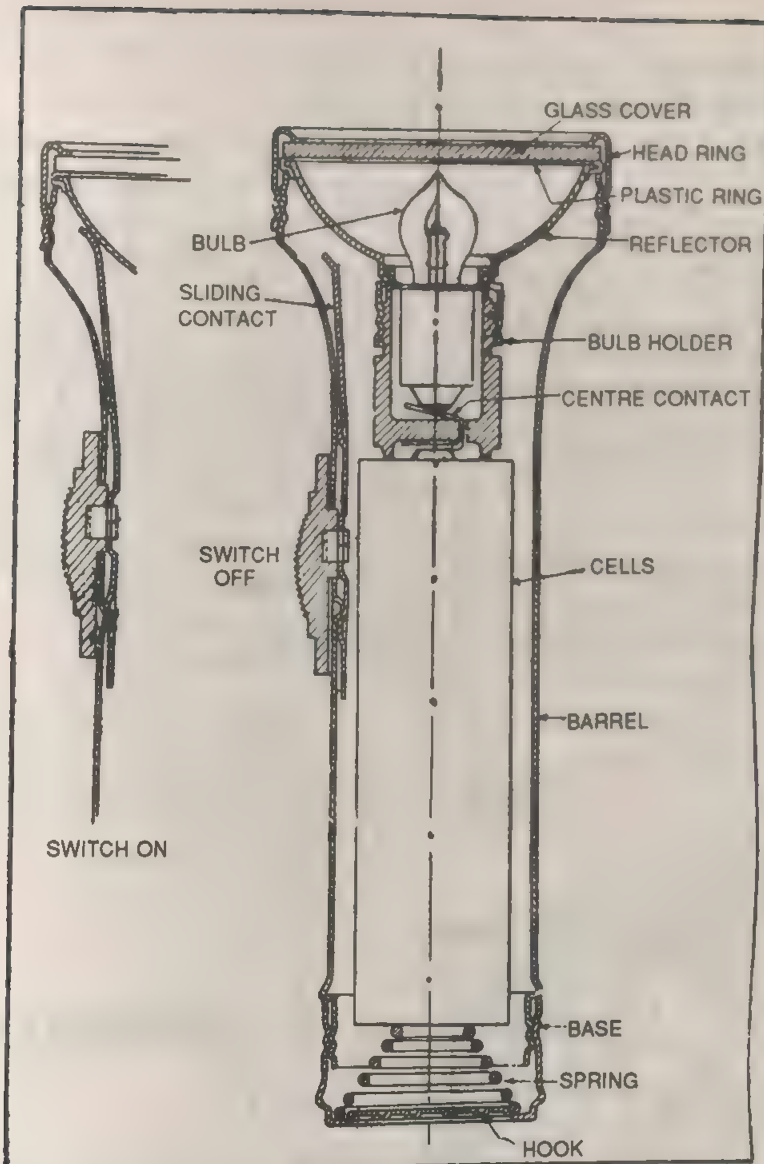


Fig. 9.5 The Torch (dry cell type)

The chief advantage of this cell is that it is portable ; its disadvantage is that it deteriorates when left unused on the shelf.

One cell is insufficient for supplying enough power to the bulb of a pocket torch. If two or more cells are connected together, they form what is called a battery. The common flash-light contains three dry cells connected in series. In series connections, the positive electrode of one cell is connected to the negative terminal of the next *i.e.*, the carbon rod of the first cell is connected to the zinc container of the second and so on. The purpose of connecting two or more cells in series is to obtain a bigger potential difference than that available with a single

cell. The potential difference between the extreme terminals (Fig. 9.5) of the battery is equal to the sum of these for individual cells.

(2) The Storage Batteries:

When the electrical energy contained in a battery composed of dry cells has been exhausted, it is thrown away. A storage battery on the other hand, is composed of what are called *wet cells.* When the energy of such a battery is exhausted it can be *recharged*. Storage batteries provide a far more convenient source of electric current. Storage cells of three types are now in general use, the lead-acid cell, the Edison cell and the nickle-cadmium cell. The lead-acid cell is by far the most widely used type.

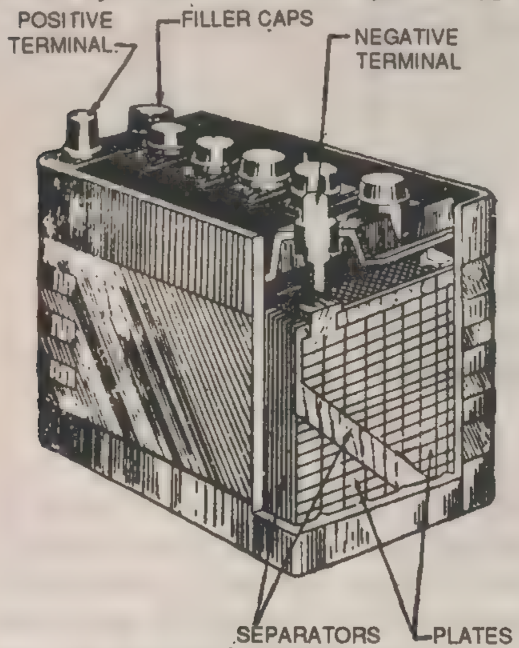


Fig. 9.6 Storage Battery

The simple storage lead-acid battery or accumulator consists of two lead plates immersed in a dilute sulphuric acid solution contained in a glass vessel. If we connect a small electric bulb across the two plates, we will find that it does not glow.

Such a battery has to be charged before it can supply electric current. For this purpose an electric current from another source is passed through it.

The use of storage batteries is wide and varied. They are used for illuminating railway carriages, for supplying power to head lights of motor cars and to start their engines. Powerful storage batteries are used to propel submarines under water. Radio transmitters and scientific apparatus of the earth's artificial satellites are powered with the help of storage batteries.

Light a bulb using one dry cell. Add another dry cell to the circuit and connect the apparatus as shown in Fig. 9.7. What happens to the bulb ? Notice the brightness of the bulb. Is it brighter than the circuit with a single cell ? Can you explain why ?

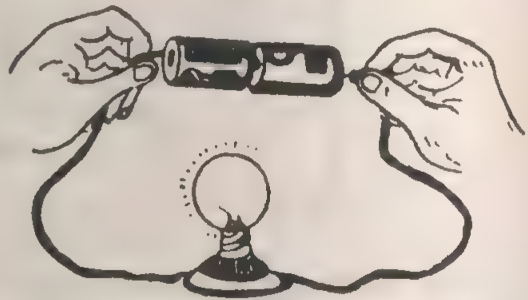


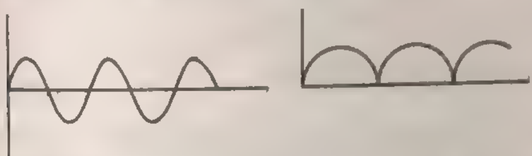
Fig. 9.7

Turn over one of the dry cells and join the two cells in opposite directions. Does the bulb light up ?

From the above activity you have observed that if you have two batteries (dry cells) connected in the proper way then the drive or push becomes stronger. Therefore there is more electricity.

9.4. A.C. and D.C.

When the electric current produced by a dynamo changes its direction of flow continuously and periodically in a circuit several times (about 50 times in general) in a second, the current is known as an *alternating current (A.C.)*. When the electric current produced always flows in one and the same direction and has a constant strength, it is known as *continuous current* or *direct current (D.C.)*.



9.5. Generators or Dynamos :

A dynamo is a machine used for generating electric current by mechanical means or a machine in which mechanical energy is changed into electrical energy.

An A.C. dynamo essentially consists of four parts – Armature coil, field magnet, slip-rings and brushes which have been shown in Fig. 9.8

Armature coil is a rectangular coil having a large number of turns of copper wire which is capable of rotation about an axis passing through the centre of the field and perpendicular to it. The field magnet is a usually an electromagnet which produces a strong magnetic field. One end of the coil is connected to a metal ring S_1 and the other to the ring S_2, called slip-rings. These rings are fixed at the same axle on which the coil is fixed and revolve with the coil. They are insulated from the axle. The brushes B_1 and B_2 are carbon strips which press against the corresponding rings. The rings maintain a sliding contact with the stationary brushes.

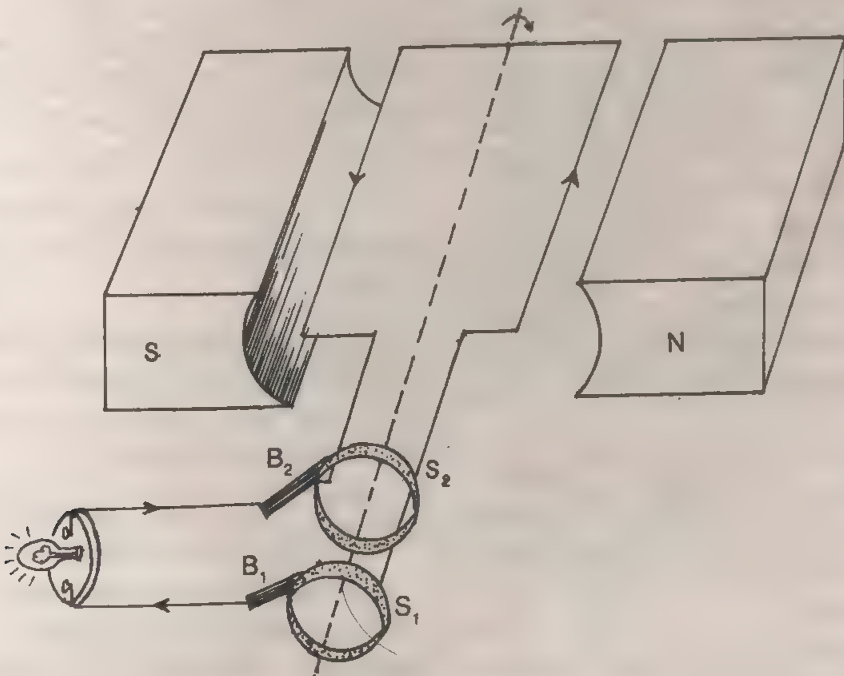


Fig. 9.8

As the armature coils rotate in the field of the magnet, magnetic flux changes and an induced voltage is generated across the two brushes. A current therefore flows out through the brush B_1 for one half revolution of the coil and through the brush B_2 for the next half. So the current in the lamp changes its magnitude and direction periodically and is nothing but a sort of alternating current (AC). The voltage produced by the generator depends on (*i*) Number of turns in the coil (*ii*) Area of the coil (*iii*) Strength of the magnetic field and (*iv*) Speed of rotation of the coil.

If slip-rings in a dynamo are replaced by split rings commutator, it becomes D.C. generator and supplies us an undirectional current of almost constant magnitude (D.C.)

9.6 Solar Cell

The magnitude of the solar energy resource is *huge*. Incident upon the earth are 173000×10^{12} watts which is 30,000 times man's current power use. Solar energy, therefore, merits very useful considerations. When light falls on Silicon or Cadmium or Boron, a current begins to flow through them. There are two types of solar batteries with strong device of Nickel-Cadmium batteries–*Silicon Solar batteries* and *Cadmium Solar batteries.*

A simple Silicon Solar cell consists of a layer of Silicon in which some Arsenic atoms are added. This layer is coated with a thin layer of Silicon and Boron. When light falls on the top layer of the cell (See Fig. 9.9) a current begins to flow in the wire connecting the two layers.

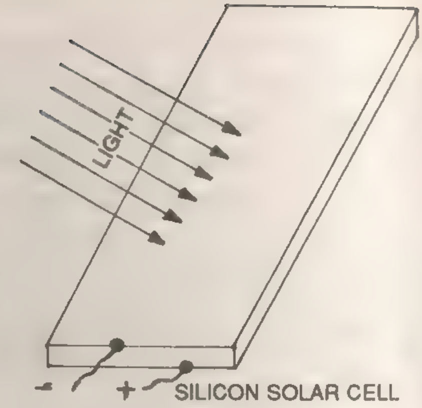


Fig. 9.9

9.7. Electric Circuit

Electricity travels along a path. If the path is broken off, then electricity cannot travel. The whole path along which electricity travels is known as *circuit*. Let us see how electricity travels.

Activity 9.1

You will need the materials shown in Fig. 9.10. Connect your materials as shown in FIg. 9.11 to light the bulb. Use adhesive tape to stick the ends of the wire to the dry cell.

What happens when you have finished your connections ? Does the bulb light up ?

With your finger trace the path of the electricity from one end of the battery to the other. Where does the path end ? Is the path broken ?

An unbroken path travelled by electricity is known as a *closed circuit.*

Disconnect one of the wires. Again trace the path of the electricity. Is the path of the electricity broken ? Does the bulb light up ?

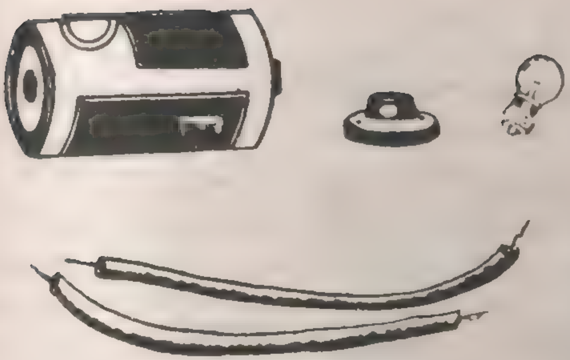


Fig. 9.10

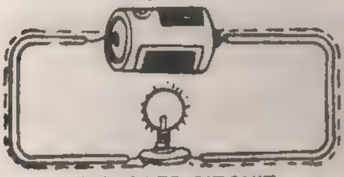


Fig. 9.11

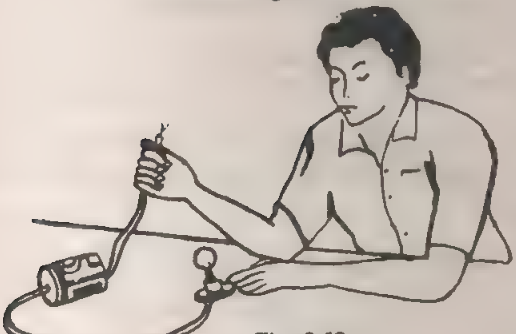


Fig. 9.12

A broken path is known as an *open circuit*. Electricity will not flow in an open circuit (Fig. 9.12).

Activity 9.2

Take four fresh dry cells and a torch bulb used for the torch with four cells. Notice the particulars marked on this bulb. Connect it with one fresh dry cell through a key (Fig. 9.13). What do you find ? Does the torch bulb glow ?

Connect two cells so that positive terminal of one is in contact with the negative terminal of the other. Such an arrangement of cells is called a *series* combination. Now connect the two free terminals of the cells again to the same torch bulb. What do you find this time ?

Does the torch bulb glow? Now connect all the four cells in the same way in series with the bulb (Fig. 9.14). What do you find this time ?

One fresh dry cell gives a potential difference of 1.5 volts, as marked on it. This potential difference is too small for a proper flow of electric current through

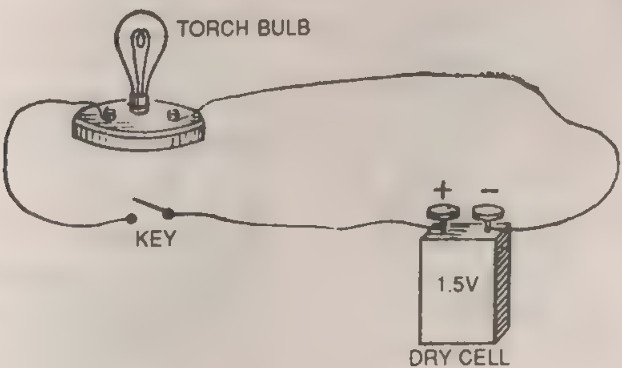


Fig. 9.13

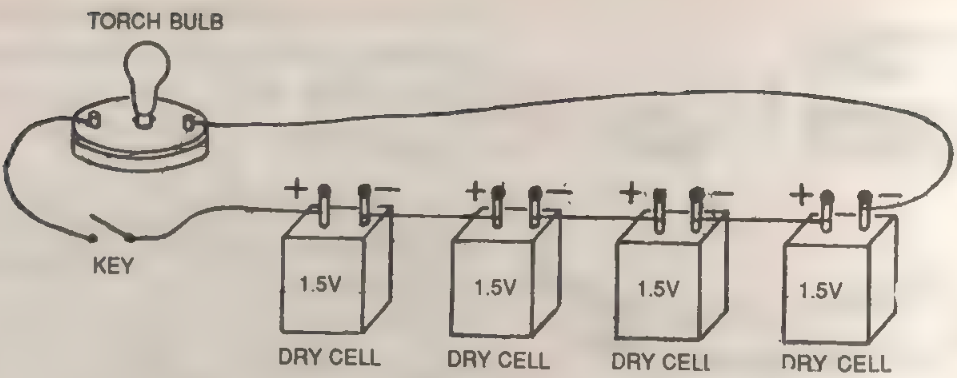


Fig. 9.14

the torch bulb of four cells. When two cells are used in series, the potential difference becomes 3 volts (1.5 + 1.5 volts), with four cells in series, a potential difference of 6 volts is obtained.

Let us see the effect of connecting similar terminals of the cells (Fig. 9.15). Such an arrangement is called a *parallel connection.*

Try to compare the glow of the bulb in this case with that of the previous arrangement. Is the glow of the bulb same as that with one cell circuit ?

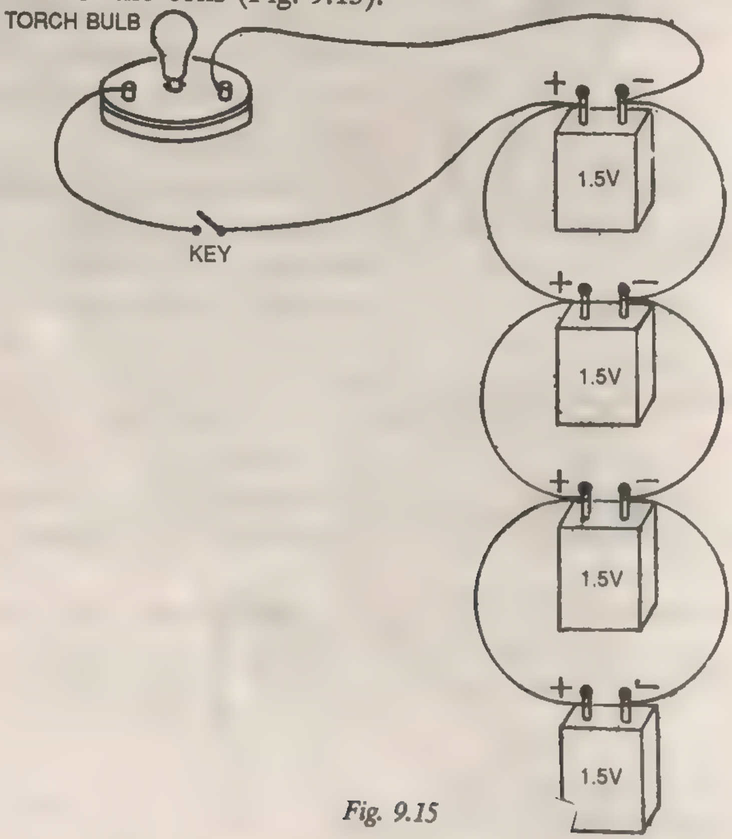


Fig. 9.15

In the case of cells arranged in parallel, potential difference of the arrangement does not increase. Such an arrangement is made for using the source of electric current for a longer time.

When we compare the two arrangement of cells with the use of two connected vessels of water. The series connection of two cells is like increasing the difference in heights (increase of gravitational potential) of water levels in the two vessels. The parallel connection of two cells is like increasing the quantity of water and not the level in the vessel at the higher level.

9.8. Effects of Electric Current

We generally observe the following effects of electric current in our daily life :

(a) It produces heat as in the case of electric irons, electric kettles, electric ovens, etc.

(b) It produces light as in the case of electric lamps and torchlights etc.

(c) It produces sound as in the case of radio and telephone.

(d) It produces motion as in the case of electric motors and electric fans.

(e) It produces magnetism as in the case of electromagnets which are widely used in industry.

We can continue our list endlessly, but we will notice that many of the items are either a repetition or a byproduct of another one. For instance, (*b*) and (*c*) above arise from (*a*) because light is not produced unless the wire is hot and sound is not produced in radios unless the tubes are heated to give out electrons ; (*d*) and (*e*) are also the same. It is therefore, possible, to group all the effects you can think of under three main headings :

1. Magnetic effect.
2. Chemical effect.
3. Heating effect.

Let us examine them experimentally. It is to be noted that electricity we get at our houses is A.C. at 220 volts and at the frequency of 50 Hertz.

Magnetic Effect

Activity 9.3

Taken an iron nail. Use a piece of insulated wire and wind it round the iron nail (40 windings at least) leaving the two ends of the wire free. Connect the two bare ends to a battery (Fig. 9.16). Now switch on the circuit. Put the iron nail near pins or clips what happens ? The pins or the paper clips are attracted to the iron nail. The nail is behaving like a magnet. Switch off the circuit. Do the pins or clips drop off ? They do. This means that there is no magnetism in the iron nail any more.

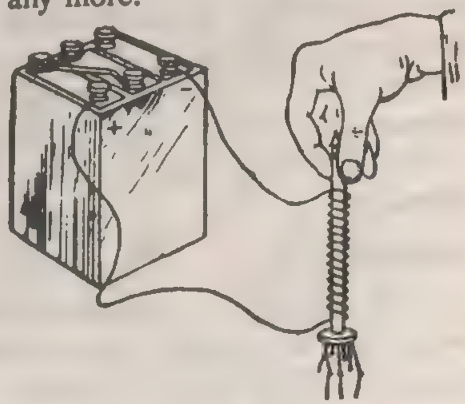


Fig. 9.16

When electricity is passed through the wire wound round the nail, magnetism is produced. We do not get the magnetic effect if no electricity passes through the wires. Thus we can say that electricity can produce magnetism.

Chemical Effect

You must have used silver-plated spoons and tin-plated cans and you have seen chromium-plated bumpers and door handles in cars. They are the results of the chemical effect of electricity.

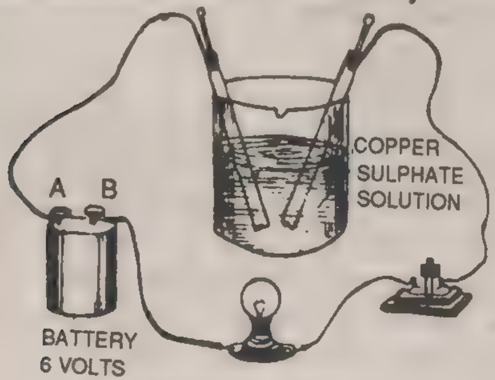


Fig. 9.17

You know that solutions of mineral salts, acid and alkalies (electrolytes) will allow electricity to pass through them while other liquids, such as distilled water, oils and solutions of organic substances like sugar and alcohol (non-electrolytes) do not conduct electricity. We shall now examine more closely what happens when an electric current is passed through an electrolyte.

Activity 9.4

Take a dry cell, a small torch bulb, switch and two copper plates. Connect the circuits as shown in Fig. 9.17. The switch should be on. Touch the copper plates. Does the bulb glow ? Does it imply that by touching the plates you can close the circuit ?

You will observe that *some chemical* change takes place in the copper sulphate solution when an electric current flows through it. The metallic film of copper on the plate comes from the copper sulphate solution and the passage of electricity through copper sulphate solution has produced a chemical effect by separating the metal from its salt.

The process of producing a chemical action in liquid by the passage of electricity through it is known as *electrolysis*. Electrolysis finds many applications in industry *e.g.,* electroplating, production of copper, aluminium and a number of other metals etc. The storage battery also works on the principle of chemical effect of electric current. The rusting of iron is prevented by electroplating it with nickel or chromium.

9.9. The heating effect of an electric current

When an electric current is passed through a wire between the ends of which there is potential difference, energy is absorbed which reappears in the form of heat. Heat is the kinetic energy or energy of vibration of the atoms or molecules. When the electrons constituting a current pass through a wire they keep hitting and jostling the atoms in their path, causing the latter to vibrate more energetically and in this way generate heat in the conductor. A current produces heat

not only in metallic conductors but also in liquids and gaseous conductors.

Dr. Joule concluded in 1841 as result of a series of experiments that when an electric current flows in a conductor the heat liberated is directly proportional to :

(a) the square of the current (I^2)
(b) the resistance of the conductor (R)
(c) the time during which the current is flowing (t).

These are known as *Joule's laws for the heating* effect of an electric current.

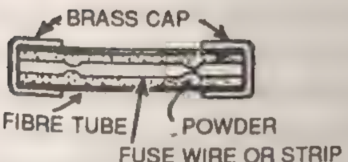
9.10 Applications for the Heating Effect of a Current

Fuses

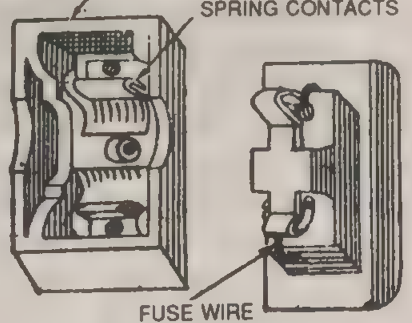
Electricity is one of the home's most versatile servants, being used for lighting, heating, cooking and entertainment. It can also be dangerous. One of the commonest dangers, especially in older houses, is overloading the circuits. The wires are then forced to carry higher currents than they are designed for and they overheat. This can cause fires inside the walls. All electrical circuits should contain fuses, which are protective devices used in electrical circuits to prevent too heavy a current being drawn from the supply or through the house wiring which might have been damaged.

It consists of a short length of thin wire, generally of tin or some alloy (tin and lead) with a low melting point mounted in a porcelain holder (Fig. 9.18) and inserted in series with the circuit, so that all current flows through the fuse. The thickness of the wire is so chosen that, when the safe maximum allowable current is exceeded, sufficient heat is generated in the fuse to raise its temperature to melting point. If the fuse melts (or blows), the current is automatically switched off thus creating an open circuit. The fuse has to be replaced before the circuit can be used again.

The use of too thick a fuse may allow too much current to flow, with the possibility of damage to the electrical wiring of the house or factory. Fuses should be closely matched to the current being used. It is no use using a 30 amperes fuse for



(A) CARTRIDGE FUSE (FERRULE TYPE)



(B) RE-WIRABLE FUSES

Fig. 9.18 Types of Fuses

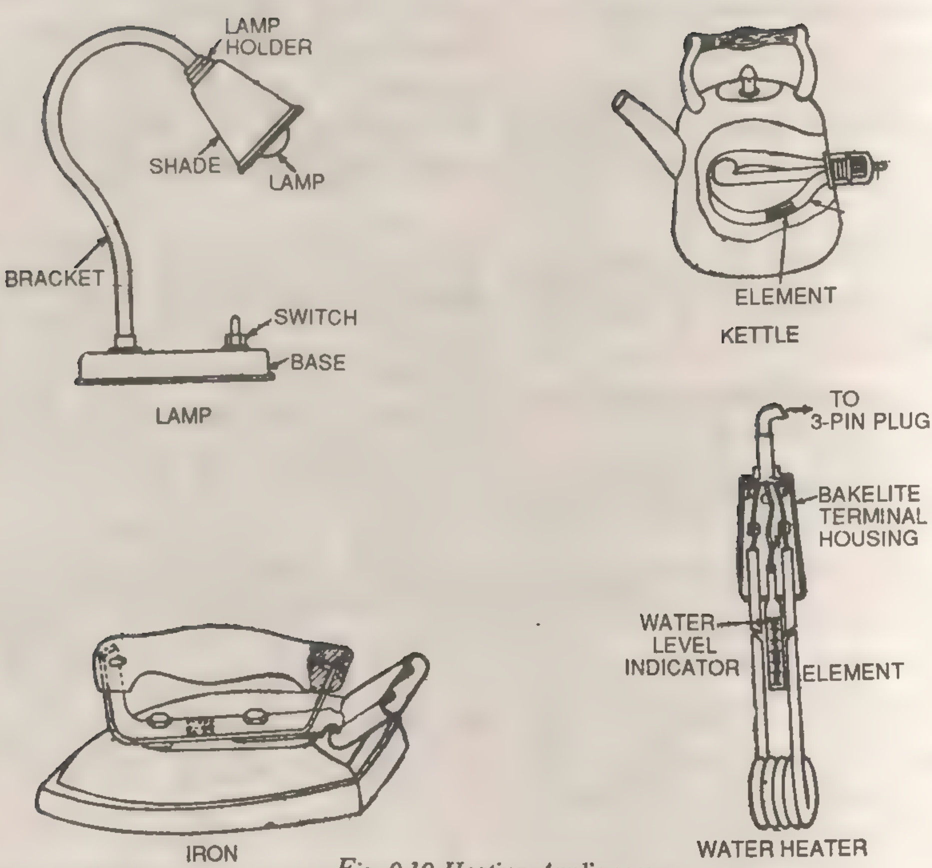


Fig. 9.19 Heating Appliances

a lighting circuit drawing less than half an ampere. On every piece of electrical equipment is a nameplate, giving its voltage, frequency and power rating. From this the required fuse size can be determined. A general rule is to allow 4 amperes per kilowatt and then use a fuse of the next higher available rating. The preferred values are 5 and 15 amperes for wire type fuses. Modern practice is to use the cartridge fuse secured by clips. This is just a wire contained in a sand filled, insulated tube. The preferred values for cartridge types are 3 and 13 amperes.

Heating Appliances

Many of these are used in the average home and common examples are electric radiators, kettles, toasters, jugs, stoves, irons, water heaters etc. (Fig. 9.19)

All of these devices make use of the heating effect of an electric current. In each case, a heating element (Fig. 9.20) is used. The element wire is usually composed of nichrome (an alloy of nickel and chromium) which has a very high melting temperature. As a rule, the wire is of such a size that the heat developed will not raise the temperature higher than red

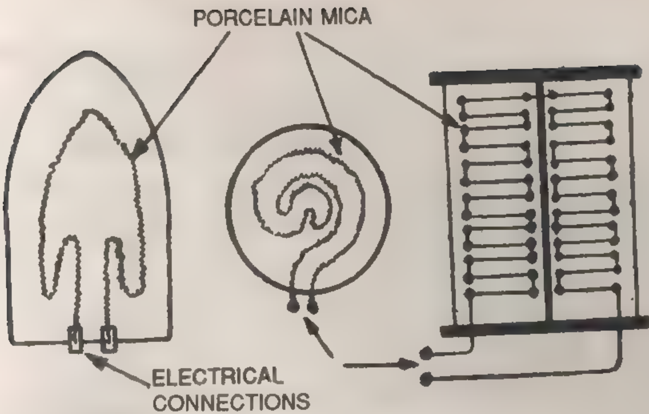


Fig. 9.20 Heating element

hot. The element is supported on a form made from some heat-resistant insulator, such as mica or porcelain.

The element of the radiant heater gives off invisible infra-red radiation. This warms objects that it touches, thus being only suitable for personal heat. The element is put in a frame with a polished reflector to beam the heat into the room.

In industry, the heating effect of a current is also utilised for melting metals and also in electric welding. In agriculture it is used for foddersteamers, hay drying, incubators, etc.

Electric Filament Lamps

The first incandescent electric lamps were made by Edison in 1879. These had a filament of carbonised bamboo fibre, sealed into an evacuated glass bulb. When a suitable current was passed through the filament, it was heated to incandescence and emitted a yellowish light. These lamps were not very efficient and had a very limited life.

Tungsten filaments were first used in about 1910. These could be heated to a higher temperature and so gave more light for a given amount of electrical energy. In the modern incadescent lamp the filament consists of a very fine tungsten wire made into a closely coiled spiral, which is then contained in a glass bulb filled with an inert gas, usually argon or nitrogen.

The filament is heated by the electric current to a temperature of about 2500°C. The gas present tends to reduce the vaporization of the metal of the filament. This allows the filament to be operated at a higher temperature with a consequent increase in efficiency (*i.e.*, it uses less electrical energy for a given amount of light radiated).

9.11. Conductors and Insulators

Not everything allows electric charge to pass through it easily. Some materials allow electric charge to pass through them easily, others do not. The materials that allow electricity to flow through them easily are known as *conductors*. Those through which it is difficult for electric charge to flow are known as *insulators* or *non-conductors*.

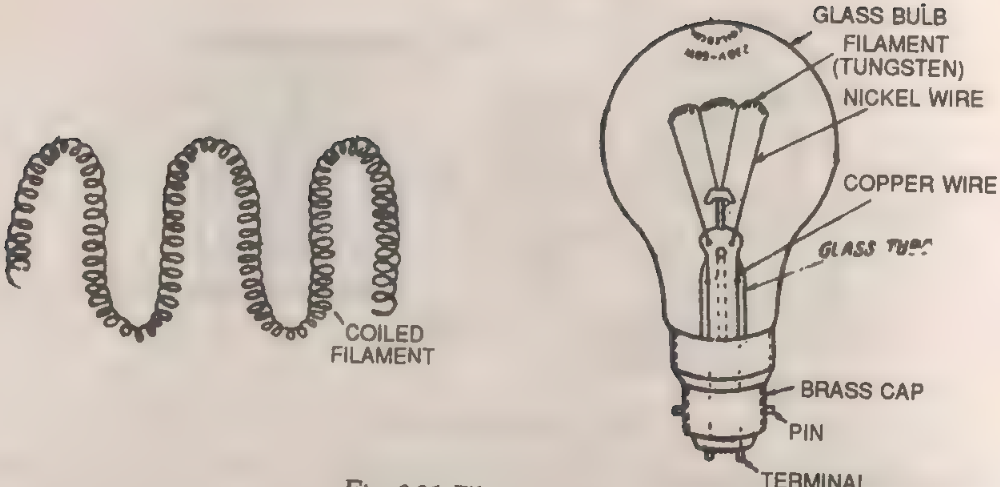


Fig. 9.21 Filament lamp

Let us test and see which are the materials that are conductors and which are the materials that are insulators.

Activity 9.5

Suspend a small brass ball by a silk thread and then join the ball to the brass knob of a gold-leaf electroscope by means of a copper wire as shown in Fig. 9.22. Charge the ebonite rod and touch with it the brass ball. What happens to the leaves of the electroscope ?

Now substitute a silk thread for copper wire. Charge the ebonite rod again and touch with it the brass ball. What happens now ?

In the first case using copper wire, the leaves of the electroscope diverge. Apparently the charge on the brass ball is transferred to the electroscope by the copper wire. In the second case when the silk thread is substituted for the copper wire, the leaves of the electroscope do not diverge because the charge has not been transferred to the electroscope by the silk.

Repeat the experiment using a number of substance. Separate them into conductors and insulators.

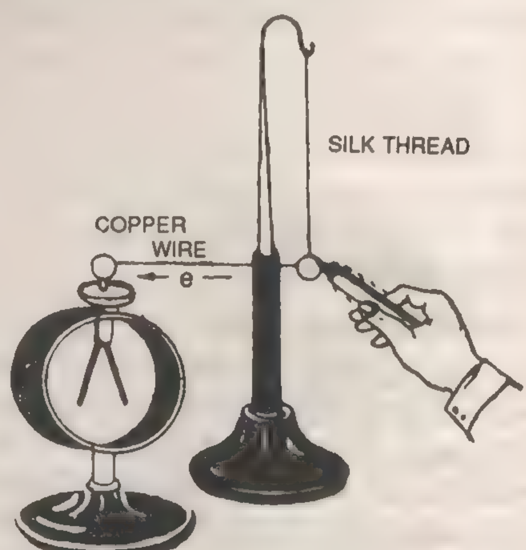


Fig. 9.22

Most metals are good conductors. At normal temperature, silver is the best conductor ; copper and aluminium follow in that order. Graphite, the human

body and certain solutions are good conductors also.

Good insulators are silk, paraffin wax, glass, dry air, mica, hard rubber, bakelite and many plastics ; porcelain insulators for power line ; etc.

Conductivity and insulation of a certain material are relative terms. There is no substance which is a perfect insulator. There are certain substances whose property of carrying charges lies between conductors and insulators. Such substances are cotton, wood, paper, etc.

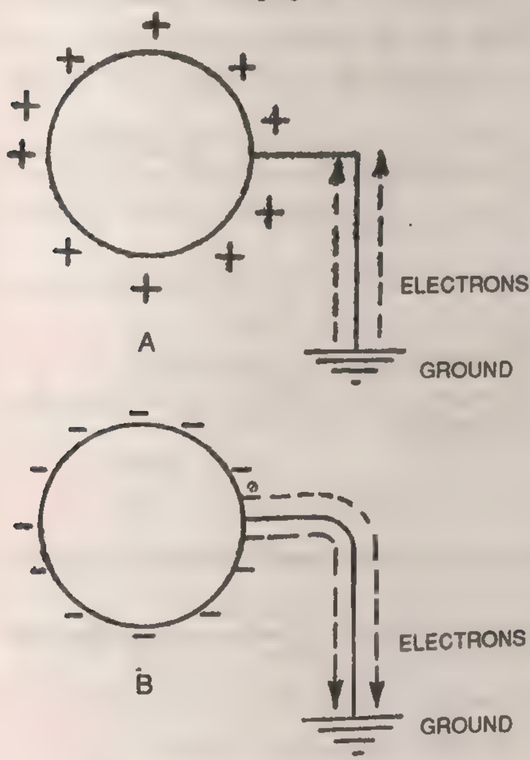


Fig. 9.23

Telegraph and telephone wires are made of hard-drawn copper as they are good conductors. These wires are placed on inverted cups of porcelain which are insulators and thus avoid the leakage of charge through poles. Copper wire is used in electrical wiring at home as it is a good conductor.

A good conductor contains a large number of free electrons and if such a material is brought into contact, with a charged body, a transfer of charge takes place. An insulator has few free electrons because even the outermost electrons are rather firmly held within the atom structure. Thus, the transfer of charge through an insulator is usually negligible.

9.12 Hazards of Electric Currents

You must have heard of firing in an electrical wiring in a building due to short circuiting. This firing may spread in the whole building, producing damage to the building itself and its occupants. Similarly, if you happen to be in contact with a metallic conductor carrying a current while you are bare footed, you have an electric shock. This shock can damage the cells in our body and cause death. The magnitude of damage caused depends upon the strength of the electric current and on the time duration for which it flows through our body.

The safety devices such as fuse and the earth wire is provided in an electric circuit to keep away ourselves from the hazards of electric current. The electrical appliances are usually provided with a green wire called *earth wire.* This wire connects the frame of the appliance to the ground. If accidently any current flows through the frame, it is led into the earth through earth wire. Thus, the person working on the appliance is safe.

SUMMARY

1. The flow of electric charge is called an electric current which flows only when there is an electric potential difference.

2. The electric condition of a conductor which determines the flow of electric charge from it to another conductor placed in contact is known as its electric potential.

3. Potential difference is the difference in electrical pressure produced by a battery. The potential difference between any two points in an electrical circuit is measured in volts.

4. One volt is the potential difference between two points when the source must supply 1 joule of energy when 1 coulomb of charge passes between them.

5. The earth is taken to be at zero potential because it has a huge capacity for electric charge and any addition or removal of a small charge would not alter its potential appreciably.

6. The potential of a positively charged body is above the potential of the earth and the potential of a negatively charged body is below that of the earth.

7. Dry cell is a sourse of electric current and it converts chemical energy into electrical energy.

8. When positive terminal of one dry cell is in contact with the negative terminal of the other, then the cells are said to be connected in series. In such an arrangement, the potential difference gets increased.

9. When positive terminal of one cell is connected to the positive terminal of the other cell and the negative terminal of one cell is connected to the negative terminal of the other cell, then the cells are said to be connected in parallel and the potential difference of the arrangement does not increase. By such an arrangement, we can draw electric current for a longer time.

10. In order to avoid accidents, we should know the care and safety devices required for using mains supply.

11. The process of connecting a conductor to earth is called earthing or grounding.

12. In house wiring all distribution circuits have the same potential difference (220 V), as they are connected in parallel. The frequency of voltage is 50 cycles/sec.

13. There are different types of primary cells as

(i) Voltaic cell (ii) Leclanche cell (iii) Dry cell

14. A storage battery is made up of secondary cells which can be recharged by the electric current from mains.

15. A generator or a dynamo is a permanent source of electricity. It converts mechanical energy into electric energy.

16. A solar cell converts light energy into electric energy.

17. The whole path along which electricity travels is known as circuit.

18. The various effects of electric current are : (i) Magnetic effect ; (ii) Heating effect ; (iii) Chemical effect.

19. A strong electric current flowing through our body can damage the biological cells in our body and can cause death.

20. The materials that allow electricity to flow through them easily are called conductors and those through which it is difficult for electric charge to flow are called insulators.

QUESTIONS

1. What is an electric current ? What is the condition for electric current to flow ?

2. What do you mean by potential difference ? What is its unit ?

3. What do you mean by positive and negative potential ?

4. What is a Simple Voltaic Cell ? Describe its working.

5. Draw a diagram of dry cell and explain its working.

6. What is a storage battery ? Describe it.

7. (a) What is a generator ?

(b) Describe the working of a simple generator.

8. What is A.C. and D.C. ? Distinguish between them.

9. Which current do we get from power house at our place ? A.C. or D.C.

10. What is the voltage and frequency at which we receive electric power at our houses ?

11. What is an electric circuit ?

12. What is a solar cell ?

13. Write short notes on the following :

(i) Electric fuse (ii) Heater (iii) Filament lamp

14. Distinguish between conductors and insulators.

15. How can you show by a simple experiment that electricity can produce chemical effect ?

16. Classify the following under:

(a) Electrolytes

(b) Non-electrolytes.

Distilled water, common salt solution, sulphuric acid ; copper sulphate solution ; orange juice.

Is mercury an electrolyte ?

17. Fill in the blanks :

(i) Most of the electric wires we come across are covered with .... or ....

(ii) Some of the electric bells work with the electric current from the .... and others on electric current from .... or ....

(iii) The telephone is worked by ....

(iv) An electric bulb has .... points for contact with the bulb holder and the bulb is connected to the .... again with .... wires.

(v) Electric current produces .... effects.

(vi) .... is a device by means of which we are able to detect and identify charges.

(vii) A body need not necessarily be .... with another body to be charged. It is quite sufficient, for instance, to .... it with some other .... body.

(viii) Telegraph and telephone wires are made of copper as they are good ....

18. Write 'T' against the sentences which are True and 'F' against the sentences which are false in the following statements :

(a) The materials that allow electricity to flow through them easily are called insulators. ....

(b) Electricity can not work an electric bell. ....

(c) There are two different kinds of charge. ....

(d) Joule's law of heating effect of current $H = I^2Rt$. ....

(e) Earth is a good conductor of electricity but has no capacity for electric charge. ....

19. (a) What are the various sources of electrical energy ?

(b) What is the principal advantage of using a dry cell as a main source of electric current ?

(c) What is the advantage of connecting the dry cells in series ?

20. Classify the following effects of electricity under the headings ; magnetic, chemical and heating :

(a) The telephone is worked by electricity.

(b) Electricity can work an electric bell.

(c) Electricity produces light.

(d) Electricity is used in the electric iron.

(e) Electricity can work a refrigerator.

(f) Electricity can work an electric fan.

(g) Electricity can work a radio.

(h) A car can be started by electricity.

21. Show by a simple experiment that when current flows inside a wire, magnetic effect is noticed near it.

22. How can you show by a simple experiment that electricity produces heat ?

List a dozen ways in which the heating effect of electricity has been used.

23. State the material of which each of the following wires is made and mention the properties which make the wire suitable for its purpose:

(i) Fuse wire (ii) Iron wire (iii) Bulb filament wire

24. In a gas-filled electric filament lamp, explain the choice of

(i) the gas used

(ii) the metal used for the filament.

Explain why the connecting wire is cold, whilst the wire of the element is red hot ?

25. Fig. 9.24(A) to (D) shows circuits containing similar lamps and similar batteries. Say for each circuit whether the lamps are normally bright, over-run, under-run or quite dark. (One battery lights one lamp with normal brilliancy).

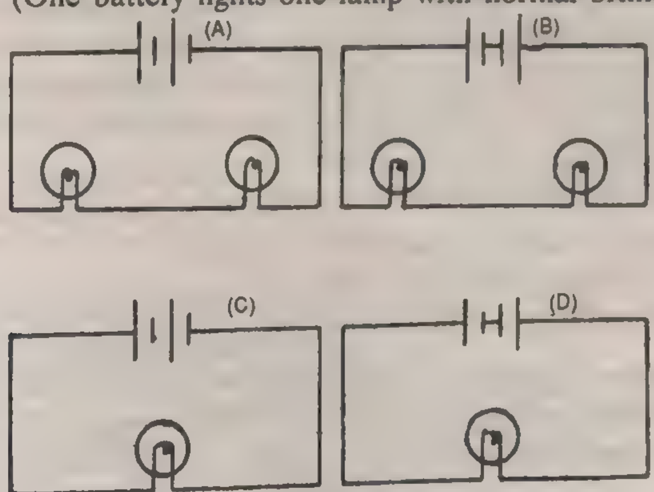


Fig. 9.24

26. What is a fuse ? Explain, with a schematic diagram, the household electric wiring.

27. How are cells connected in series ?

28. How are cells connected in parallel ?

29. Name the device which converts the following energy into electric energy and hence is a source of electric current.

(i) Chemical energy. (ii) Mechanical energy. (iii) Light energy.

CHAPTER 10

ADAPTATION AND ORGANIC EVOLUTION

10.1. Adaptability to the Environment

You have observed in your daily life that your habits, behaviour and attitude change in different places, with different people etc.

This is because you adjust your-self to a situation or environment, it is required, so that you do not feel yourself out of place.

Similarly in nature, organisms including human beings show drastic changes in their form, complexion and functioning of their body organs in different situations and climates. This is called *adaptation* to a new environment.

For example (i) there is great difference in the complexion of people living in Africa and those living in Arctic region.

(ii) A mammal living in a cold climate develops thick coat of fur than the one living in warmer climate.

(iii) A tree living in a dry climate develops more extensive roots than one living in moist climate.

Need for Adaptability

The reasons given to the above observation are that, whenever there is a change in an environment, an organism tries to change to fit itself in the new environment for its survival. This is *adaptability*.

Let us explain few examples

In human beings :

1. Whenever there is direct sunlight falling on our skin, the complexion of skin undergoes a change and gets tanned.

You know our skin is provided with some special cells which contain some colouring substances called *pigments* and, therefore, these cells are called *pigment cells.* The pigment of these cells protect our body from the strong sun rays.

This is why, people are more tanned in Africa and other countries close to the equator.

When people from U.S.A. or U.K. etc., visit such hot countries their skin gets *freckled* as the pigment cells produce pigments to protect their skin from the direct sun rays.

2. Whenever any foreign bodies like bacteria or viruses attack our body, our body immediately reacts and produces *antibodies* which fight with these foreign bodies.

When enemy (bacteria or virus) invades our body in great strength, there are just too many in the enemy party to be taken care of by all antibodies, we are

then defeated and suffer from the disease.

This is the reason, whenever we hear that a particular disease like small pox, typhoid etc., is spreading, we get ourselves *vaccinated*.

Vaccines are the mild germs of the disease, which on entering the body, produce antibodies and prepare our body to face the environment.

3. The body temperature of our body is always constant. It is 98.4°F or 37°C.

You may go to any cold country or to any hot country, but your body temperature remains the same. This is because, our body has many ways to adjust to the new environment.

4. Many processes in our body occur periodically, some are fast while some are slow.

While doing exercises our heart beat rate goes up. Because we need more energy to meet the demand of doing the exercise and to produce more energy, we need more oxygen. The oxygen is supplied to different parts of our body by blood.

In aquatic organisms

Organisms, living in water, are adapted for survival in an environment related to water.

Plants living in water :

Activity

Visit a pond and try to observe lotus plant or other water plants.

The leaves are flattened and very broad and can be seen on the surface of water. Some other plants in the pond may have ribbon like long and thin leaves (Fig. 10.1). The roots of the water plants may not be extensively well developed. In some cases, the root system may be very poor or absent.

Fig. 10.1. Giant leaves of giant water lily.

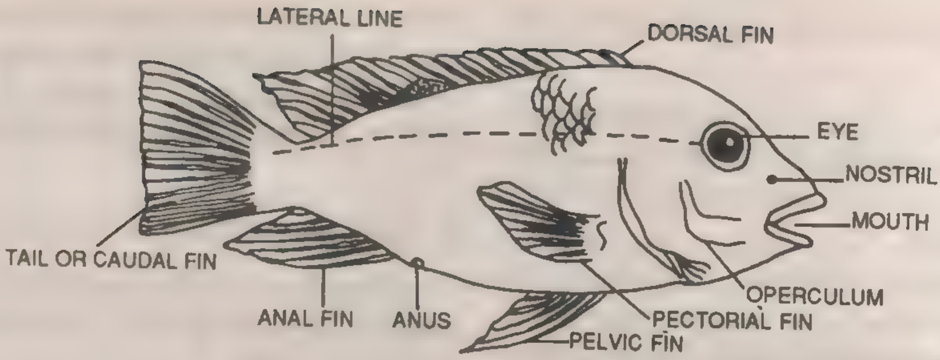


Fig. 10.2. External features of the fish.

Mechanical tissues (xylem, sclerenchyma) in roots of such plants, may not be developed.

The stem of some acquatic plants (*e.g.*, lotus) have long conducting canals for conduction.

The features vary for plants, fully submerged, free floating or partly submerged, in water.

Animals living in water

The best example to be studied in fish.

Activity

1. Observe the features of a fish.

2. Observe the movement of the fish in an acquarium.

Fish has a streamlined body that helps to move in water. (Fig. 10.2)

Fish breathes through gills covered by *operculum* (gill cover).

Gills help the fish to breathe in oxygen dissolved in water.

You are seeing, that fish is provided with different kinds of fins. These fins

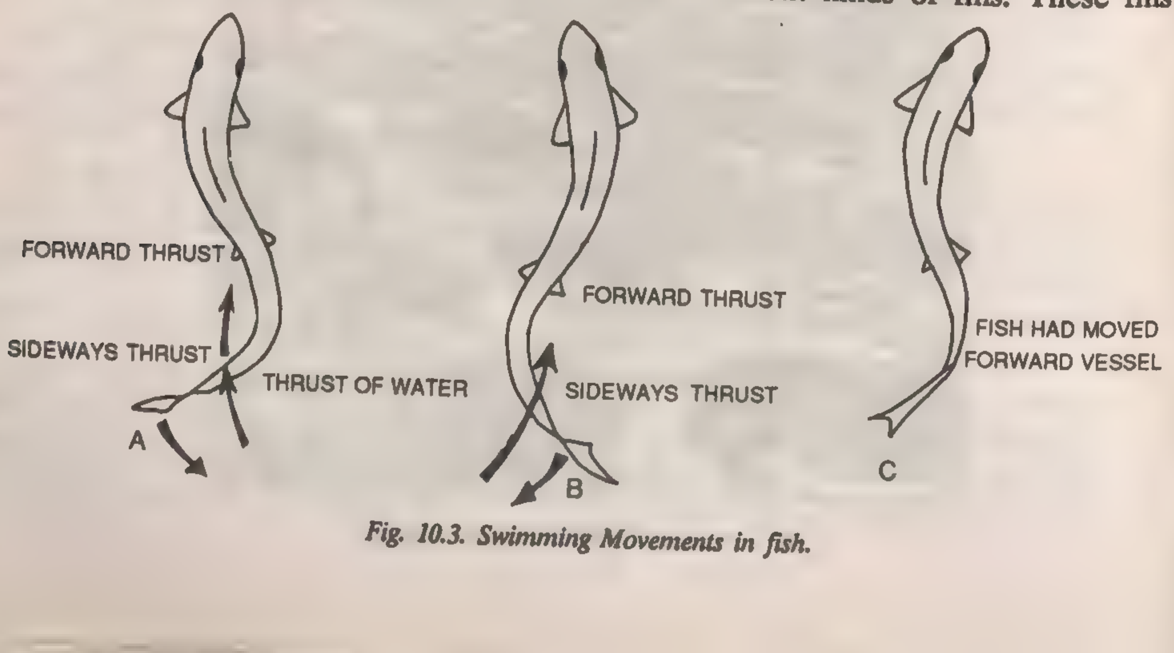


Fig. 10.3. Swimming Movements in fish.

the fish in swimming (Also, presented diagrammatically in Fig. 10.3).

The fish are provided with swim bladder. The swim bladder makes the fish buoyant. This does not let fish sink in water.

In this way, if one studies about all the organisms living in water, one can find their adaptability to live and survive in an environment of water only.

Organisms living on lands

These organisms are called *terrestrial organisms.*

Plants living on land

You have studied, in detail about plants living on land. Plants have a very well developed root structures stem organs and leaf systems. The land plants are also modified in various ways, according to the conditions of temperature and the environment in which they exist. The mechanical and conducting tissues are well developed and, thus, have acquired adaptability to survive in the related environment.

These are land plants like Cactus, living in desert conditions.

You have heard about Pine trees on the hills and mountains. There is tremendous variation for features according to their adaptability in such plants.

Animals living on land

You are all familiar with various animals living on land.

Cattle, dogs carnivores (lion, tiger) snakes Hippopotamus, rabbits etc. are some of these examples.

All these animals are adapted in their features, colour and habits according to their environment, they live in.

Special flight adaptation in birds and insects.

The bird is adapted to flight in the following ways :

(i) It has a streamlined body, which allows free movement in the air (Fig. 10.4 a and b).

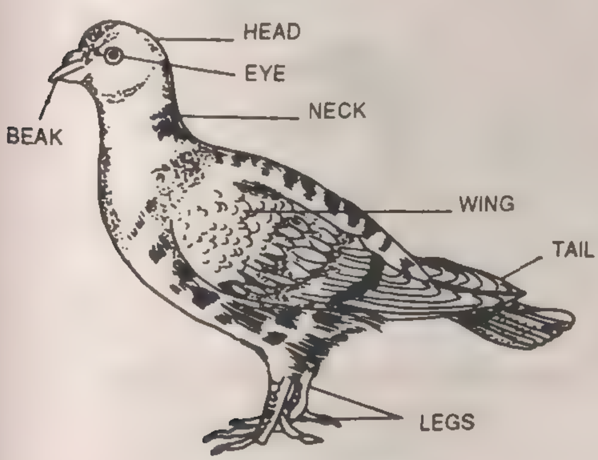


Fig. 10.4 (a) A pigeon

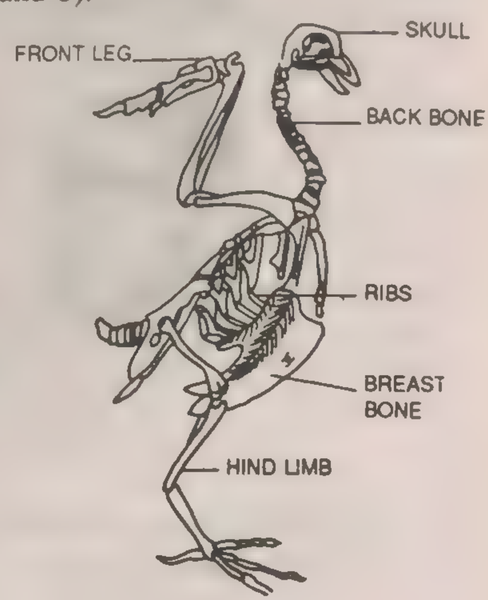


Fig. 10.4 (b) Skeleton of Pigeon.

(ii) Its front legs are modified into wings.

(iii) The bones of the bird are reduced in size, are hollow, and thus make the body weight light.

(iv) The flight muscles are very powerful.

(v) The breast bone provides a large surface for attachment of the flight muscle.

(vi) The birds have very well developed breathing system, so as to take in sufficient oxygen for providing tremendous energy, while on flight.

Insects too have adapted for flight. This is again, due to the presence of wings. You all know houseflies, butterflies and mosquitoes fly, because of presence of wings.

You have, now, seen the tremendous variation in the living world according to the environment, they live in. This is for them to fit in that environment for their survival.

10.2. Organic Evolution

The history of life on the earth is approximately 6 billion years old. The environment which we find today was not the same in the past. It has changed. All living things have also changed. Forms with simple organisation appeared earlier than the complex forms. The earliest

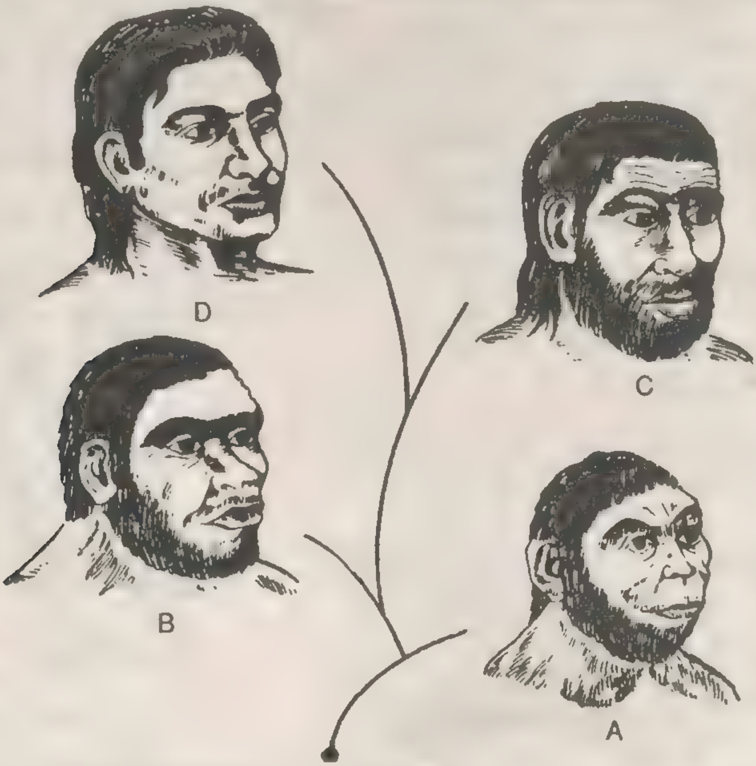


Fig. 10.5. Reconstructed features of pre-historic men on the basis of fossil remains.
(A) African ape man *(B) Jova ape man*
(C) Neanderthal man *(D) Cro-Magnon man*

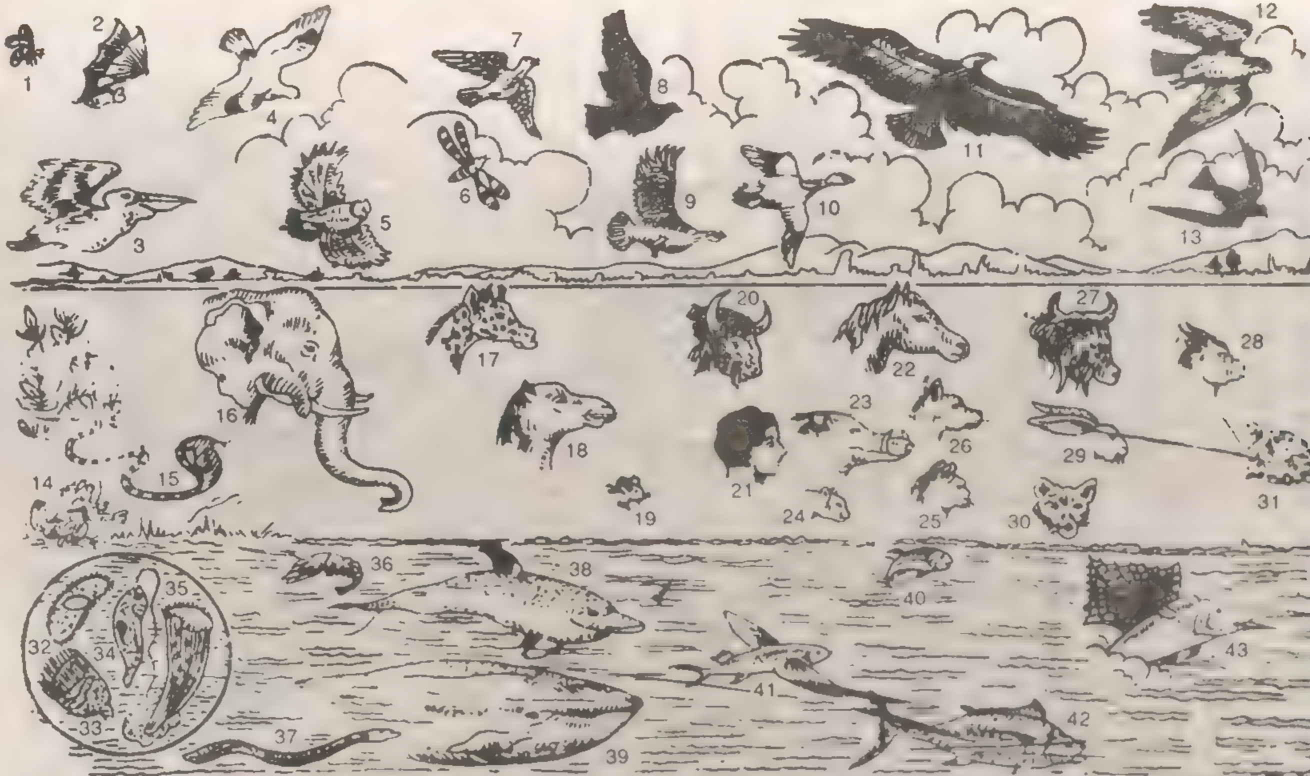


Fig. 10.6. Different kinds of animals on earth

1. Bee ; 2. Bat ; 3. Pelican ; 4. Herring Gull ; 5. Great Horned Owl ; 6. Dragonfly ; 7. Starling ; 8. Crow ; 9. Wild Turkey ; 10. Cavasback ; 11. Golden Eagle , 12. Peregrien Falcon ; 13. Indian Swift ; 14. Frog ; !5. Snake ; 16. Elephant ; 17. Giraffe ; 18. Camel ; 19. Mouse ; 20. Bison ; 21. Man ; 22. Horse ; 23. Hog ; 24. Weasel ; 25. Cat ; 26. Dog ; 27. Gnu ; 28. Gazel ; 29. Hare ; 30. Fox ; 31. Cheetah ; 32-35. Various Protozoa ; 36. Shrimp ; 37. Eel ; 38. Dolphin ; 39. Whale ; 40. Trout ; 41. Flying Fish ; 42. Tuna ; 43. Sail fish.

living organisms were very simple, heterotrophs and had anaerobic mode of respiration.

Later, chlorophyll molecules were formed and some heterotrophs transformed into autotrophs, which carried on photosynthesis.

As a result of photosynthesis lot of oxygen was released and many organisms got an opportunity to become aerobes. All these changes took a very long period of time. As, it was a very slow process going on in nature.

While these changes were going on, earlier organisms gradually and slowly started transforming into newer (younger) organisms called *organic evolution.*

Many living things of the past have become extinct. This process of slow and gradual change is called *Organic Evolution.*

The theory of origin by evolution

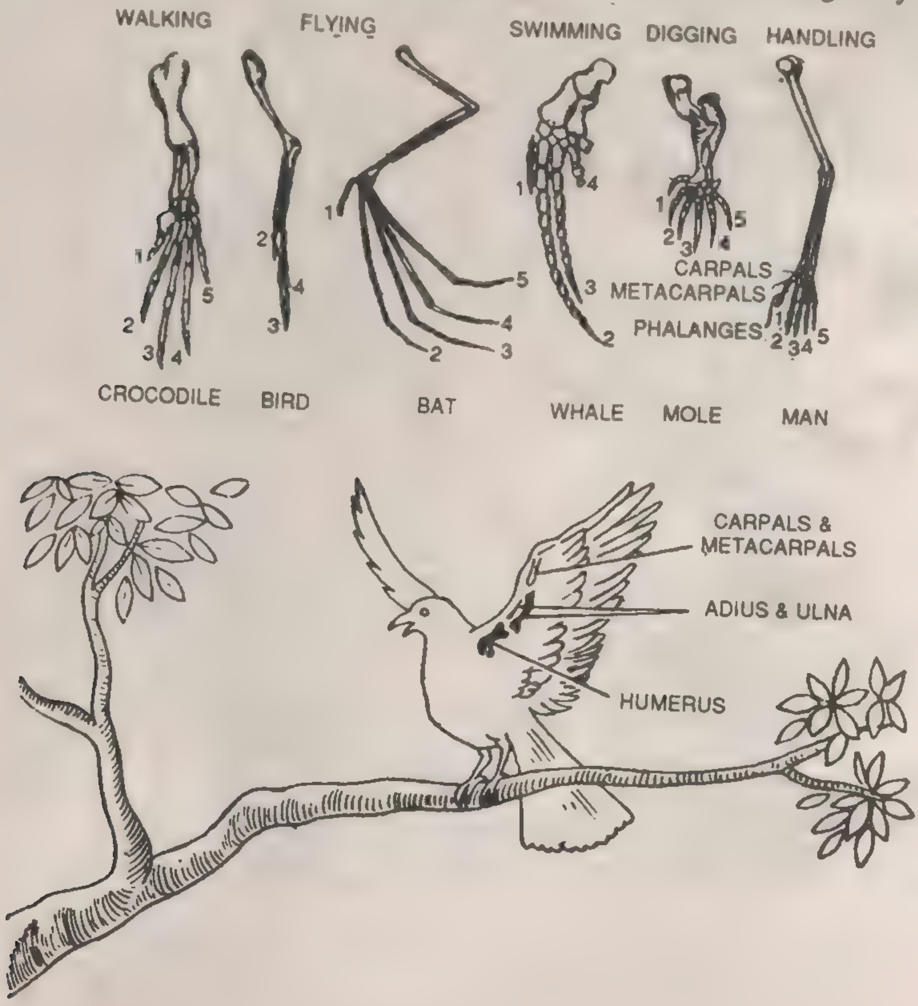


Fig. 10.7. (a) Forelimbs of different vertebrates (Homologous organs)

claimed that living things have developed as a result of change and this change has been a continuous process.

Evidences

Evidences to support evolution were drawn from various areas of biology specially anatomy, physiology and embryology. But much convincing evidences came from the study of fossils.

While examining different layers of the earth, man found the remains of plants and animals. These were named as fossils. The fossils may be either the remains of entire organisms or of parts of its, or cast of a foot print.

Importance of fossils

Scientists have recovered fossils from different parts of the world. These fossils tell us about the animals that lived in that part of the world at a particular time in the past.

Fossils tell us that the animals, which we find today, were not there in the past. They also tell us that the animals which existed in the world some centuries ago, are not found today. The dinosaurs were the predominant reptiles of the world, some millions of years ago. Today, we can only imagine of these reptiles.

The study of fossils indicates that there have been gradual changes in the structure of animals. These changes have been so slow that it has taken millions of years to form the animals of today.

The study of comparative anatomy, when combined with fossil evidences, provides a strong support to the idea of

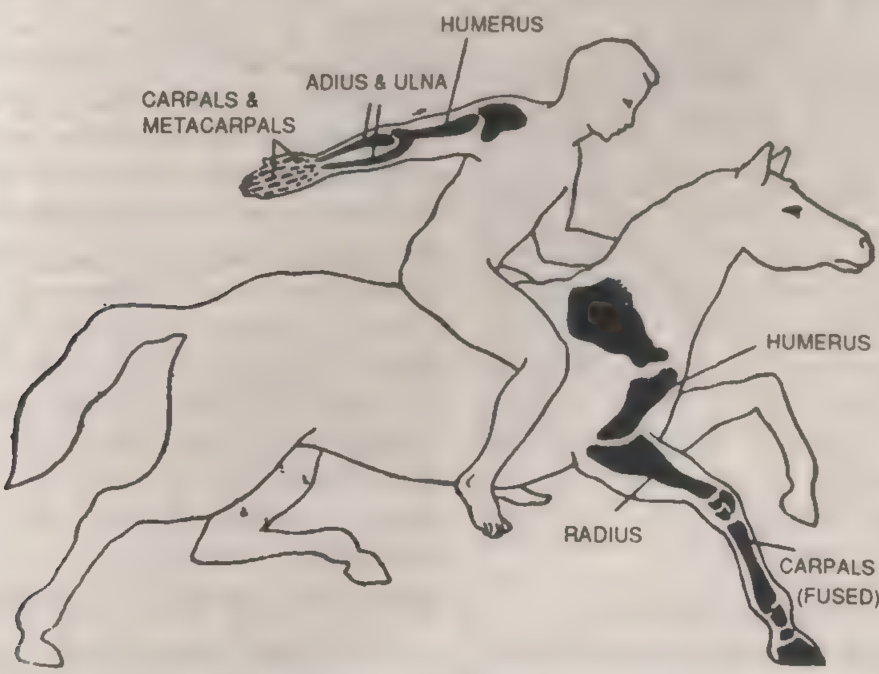


Fig. 10.7. (b) Forelimbs of different vertebrates

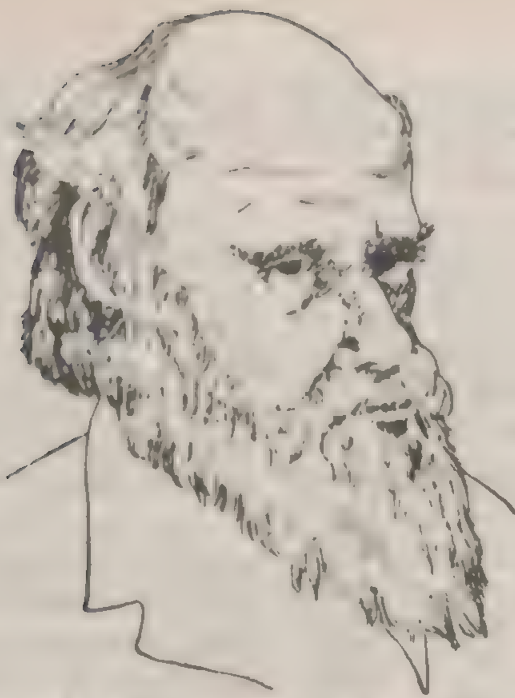


Fig. 10.8. Charles Robert Darwin (1809-1882)

organic evolution ; animals which originated earlier had a simpler organisation. This was followed by complex forms.

Comparative anatomy provides a number of other evidences. For example the Fig. 10.7(a) shows the forelimbs of different vertebrates. If you look carefully, you will find that there exists a similarity in the basic structural plan but their functions are different. In all of them, the same skeletal elements are present. In all these animals, the forelimbs developed from the same area and followed the same pattern of development. Such organs, having similar origin, may be functionally different. They are called *homologous organs.*

Theories of Organic Evolution

Numerous theories were put forward to explain organic evolution. But due to lack of proper evidences most of these theories were unable to establish themselves. Of all the theories, which attempted to explain the mechanism of evolution, you will read here only about the works of Darwin. Charles Darwin, gave the explanations on the foundation of a large number of evidences. The works of Charles Darwin not only established the idea of organic evolution, but also steered the human thoughts to a different direction. Darwin's original theory suffered from certain weaknesses due to a lack of proper information in the different areas of biology. Later, discoveries eliminated these weaknesses and today the idea of organic evolution is based on a firm foundation.

Darwin and His Theory of Evolution.

The chief aspects of Darwin's theory are mentioned below :

1. All living organisms multiply prolifically and compared to such rate, the food and habitable space remain constant.

2. No two off-springs are exactly alike. This was termed as 'variation'.

3. The prolific production of variations results in the struggle for existence. The struggle means competition. This struggle may be within the members of the same species, or between different species, or against natural factors.

4. Such competition results in the survival of the fittest. Only those variants which are able to suit themselves properly to the prevailing environment survive.

5. It means that nature selects the fit forms to survive and rejects the unfit. The variations picked up by natural selection continue to reproduce their kind. Such natural selection is operating from the early stage of life and is acting as a guiding force in the evolution of plants and animals.

Current Views on the Mechanism of Evolution :

The understanding of genetics revealed that characteristics depend upon genes and a particular collection of genes (*Genotype*) controls the characters of the individual (*Phenotype*).

Most of the changes that occur in each generation, result in the formation of variants, but does not necessarily lead to the formation of a new species. The changes are because of the changes in some genotypes. When such genotypic changes are accumulated in a population to such an extent that the group becomes reproductivity isolated, then only the group is called a *new species*. This realisation, that evolution does not occur at individual level but at the level of population, is one of the most important improvements over Darwin's theory of *Struggle for Existence* and *Survival of the fittest*. The struggle is today known as the competition amongst the variants and the fitness is understood to be dependent upon the following factors :

Sexual Selection

An individual is considered fit only when it is able to leave behind its progeny. For this reason, in higher forms the sexual selection plays an important role.

Life on Other Planets

In Mythological books, references have been made of the existence of living beings on other planets. However, it has not yet been established. Scientists are very keen to find out the possibilities of life on the other planets. Numerous expeditions have already taken place and many more have been planned. Astronauts have already visited the space and reached the moon, collected the sand and rocks from there, which are being analysed and studied by the scientists and attempts are being made to find out the possibility of existence of life on other planets. On the basis of the scientific data now available, the scientists have now analysed the possibility of existence of life on other planets.

SUMMARY

1. Adaptation is regarded as the ability of an individual organism to survive in an environment, until it attains the reproductive maturity.

2. Various organisms living in different environment adapt themselves according to the needs. They adapt with respect to movement, complexion, mode of breathing etc.

3. Organisms of today have developed from the organisms of the past. The changes in their structure have taken place so gradually that it has taken millions of years to become, what they are called today.

4. The process of slow and gradual change is called organic evolution.

5. The life originated in simpler form ; gradually and slowly become transformed to complex forms.

6. There are number of changes which speak of these changes.

7. The idea of organic evolution is as old as the theories explaining the origin of life. Darwin is associated with the idea of organic evolution, as his theory could explain the idea of organic evolution quite logically. Evolution takes place at the level of population and not at the level of individual.

QUESTIONS

1. What is the need for adaptability to the living organisms ?

2. Give reasons for the following :

(i) Why do birds have hollow bones ?

(ii) Why do people living near the equator have dark complexion ?

(iii) Why do fish breathe through gills ?

(iv) Why do acquatic plants not have mechanical tissues ?

(v) Why do animals living in cold climate have thick fur coat ?

3. How do birds adapt themselves for flying ?

4. State whether the following are true or false :

(i) All living organisms are specially created.

....

(ii) Dark complexion (tanning) because of sitting in the sun can be inherited.

....

(iii) Life originated only once as a simple speck of substance.

....

(iv) From a simple speck, complex forms of organisms were evolved.

....

(v) All organisms show some relation or the other with one another.

....

5. What is organic evolution ?
6. What are fossils ? What do fossils tell us ?
7. What are the important features of fossils ?
8. What are homologous organs ? What is their significance ?
9. Why is the name of Darwin associated with organic evolution?
10. Discuss Darwin's theory of Natural Selection ?
11. How has Darwinism been modified in recent years.

ACTIVITIES

1. Make a chart showing homologous organs.
2. Make a visit to Natural History museum.
3. Make a list of adaptations, you see in (take help from your teacher).

(i) Cactus plant and Camel to -- live in deserts.

(ii) Frog to live in a Pond.

(iii) King fisher that is a bird, but catches fish from pond.

CHAPTER 11

USEFUL ANIMALS AND PLANTS

Plants and animals, around us, have tremendous importance in our lives.

There are animals, we have studied, which harm us by carrying disease causing organisms. There are also animals which cause diseases to us. There are plants, which are poisonous. We should not forget, the bite of a poisonous snake is very fatal too. Animals like Scorpion etc. have poisonous sting which can be fatal to humans.

Animals like locusts, rice grasshoppers etc. cause damage to the standing crops. Do you think, animals and plants are only harmful to us ?

No, it is not possible for human beings to live without animals and plants. They have so many useful affects on our daily lives, which are indispensable.

We find so many animals in and around our homes and schools. We go to the zoo to see some other animals. The picture given below shows some such animals.

In the good old days, all these animals used to roam about uncared for.

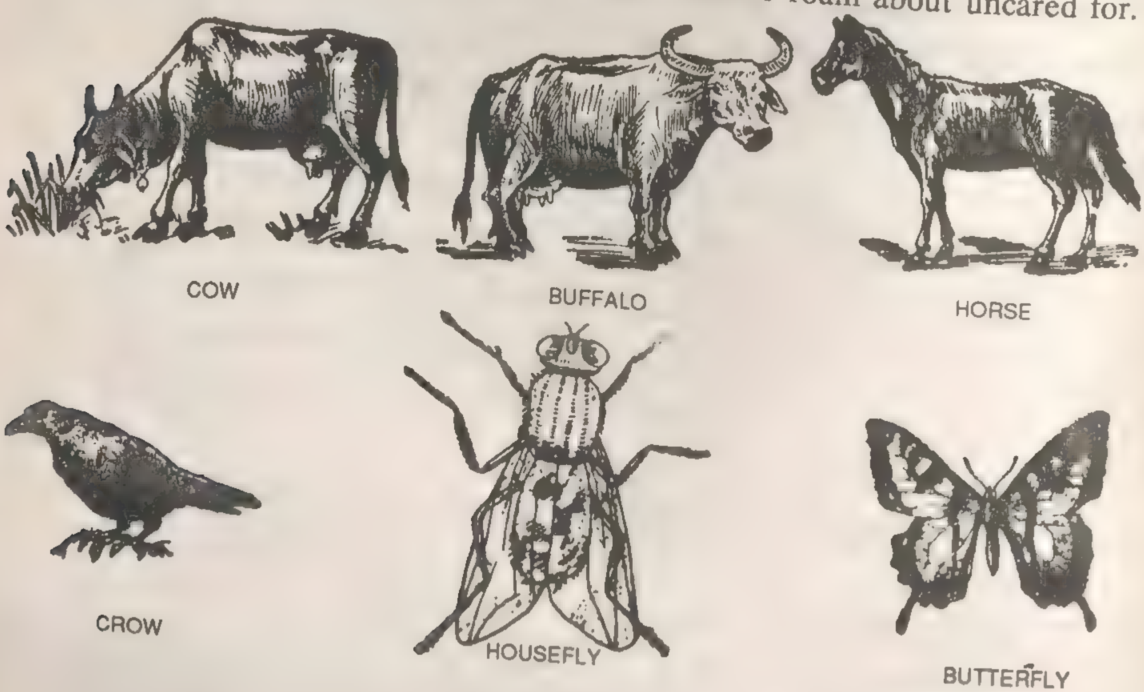


Fig. 11.1

With the passage of time, man found that he could make use of these animals. he started keeping them near his home and finally domesticated them. Can you think of some of our domestic animals ? There are some animals, such as the dog, cat, parrot, rabbit, tortoise and gold fish (in an aquarium), which some of us keep as pets. Still certain other animals like the frog, toad, crow, housefly, mosquito and Beetles are not invited by any of us. Yet, we find them in our homes. these are the wild animals. List some more wild animals in consultation with your teacher.

Importance of Animals

Animals are of great importance to man in many ways. Certain animals provide man with food, milk and its products, such as cheese, butter and cream. Such products are obtained from cows and buffaloes. Fishes are of great use to man. There are many edible fishes with important food value. Some of these are Rohu, Mrigal, Sardine, Pomphert, etc. Fish is a popular food in the coastal parts of the country. Some like Cod fish as yields important oils rich in vitamins A and D.

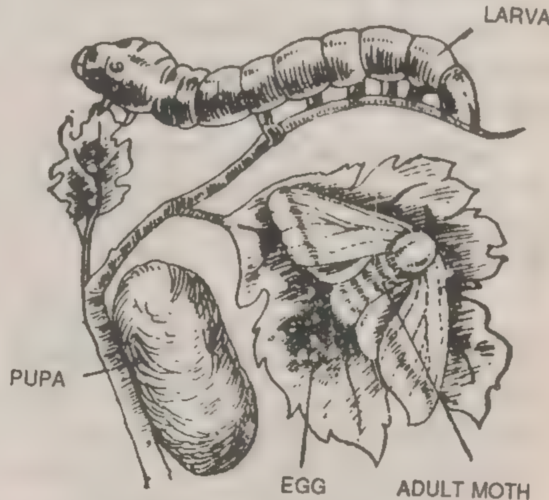


Fig. 11.3. A Silk Worm Moth

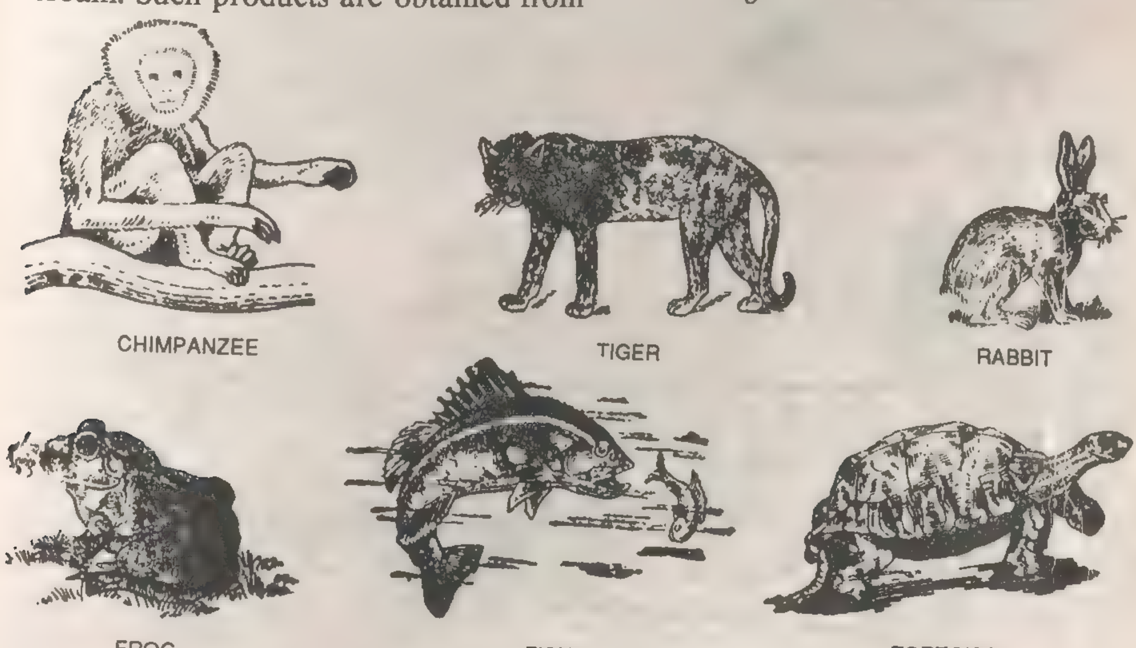


Fig. 11.2. Some common animals.

Mutton, pork and eggs are other food products obtained from goats, pigs and hens respectively. The honey bee provides us with honey and bees-wax. Honey is used as a blood purifier. It is also used as a preventive against cold and cough.

Animals also provide material for clothing. The silk-worm moth (Fig. 11.3) gives silk. Wool is made from the hair of lambs and sheeps.

Leather is an important item. It is obtained from the hides of animals. We make bags, boxes, shoes and certain types of dresses from leather.

Lac [Fig. 11.4 (a)] is secreted by the lac insect [Fig. 11.4 (b)]. It is used to make shellac, a product used to make water-proof wires and also to manufacture paints, varnishes, polishes and on the preparation of gramo-phone records.

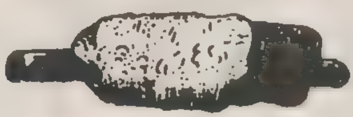


Fig. 11.4 (a) A Twig encrusted with Lac.

Butterflies and bees help in pollination. Bees-wax is a useful product, used in manufacturing of sealing wax, plasters, candles and ointments.

Fig. 11.4 (b) A Lac Insect.

We obtain bees-wax from the honey-combs of the honey bee.

We get pearls from the pearl oysters. Fancy buttons are also made from the oyster shells. Horns and hooves of many animals are used to make buttons and other articles of decoration.

Clams, mussels and corals give us lime. Corals are also used for decoration in homes. Similarly Ivory from elephant's incisors (teeth) are used.

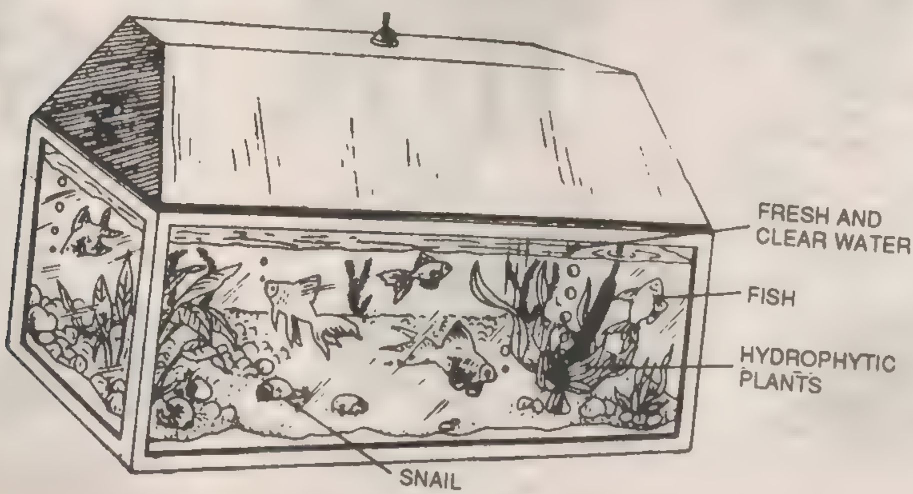


Fig. 11.5. An aquarium.

An aquarium (Fig. 11.5) is another piece of decoration in a sophisticated drawing room. It is incomplete without the beautiful fish in it. An aquarium is of utmost importance to the student of biology. It teaches him the inter-dependence of plants and animals.

Pollination

Can you think of some other indirect usefulness of animals to man ? Animals such as the bees, butterflies, moths, bats and birds, visit flowers. During their visits, they perform the very important task of carrying pollen grains from one flower to another flower, thus bringing about cross pollination. There would have been no fertilization, no fruit and seed formation in the absence of pollination and the man would have been without his food supply from plants.

Many birds eat many harmful insects which destroy crops. Many insects also keep a control over other agricultural pests. The lady-bird beetle preys upon the aphid (green fly) which is a pest. So, they help man by way of keeping a biological control.

Bones and blood of animals are used as organic fertilizers. Crushed bones are also used in the sugar industry.

Many animals act as natural scavengers and clean our surroundings by eating away the dead or decaying bodies of plants and animals. Some such animals are the crow, vultures, termites, dung beetles and prawns.

11.2. Useful plants

We select the plants useful to us and grow them near dwelling places, so that, we can easily use them when needed. Wheat, maize, rice, cotton, coconut, many fruit trees and vegetable plants are examples of such cultivated plants.

Plants are a part of our life. Let us consider some of their uses.

Uses of Plants

Our first need is food. Plants provides us with food directly or indirectly.

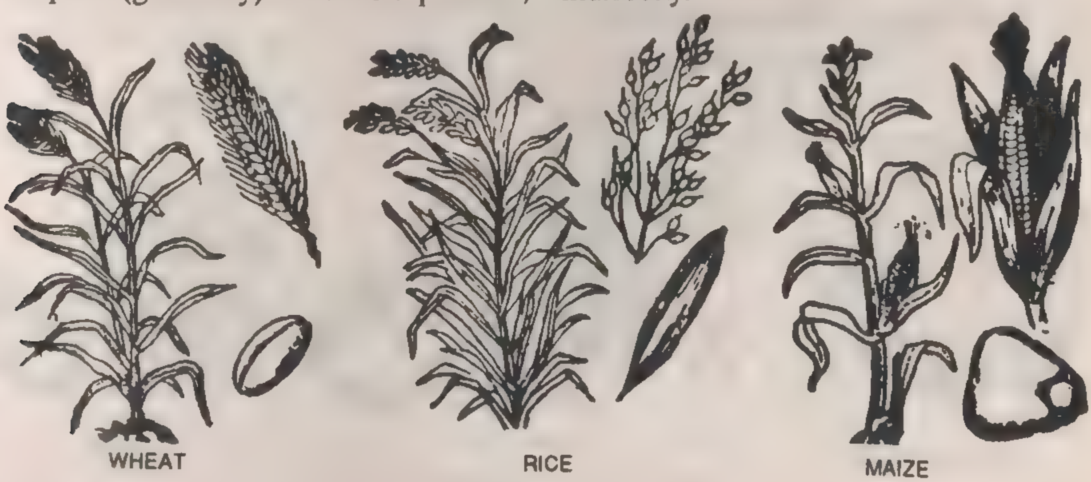


Fig. 11.6

Fig. 11.7.

The table given below shows the various foods that we get from plants.

TABLE 11.1

1.	*Cereals*	: wheat, maize, rice , barely, millets.
2.	*Pulses*	: beans, peas, gram, lentil.
3.	*Vegetables*	: potato, spinach, ladyfinger, brinjal, gourd, garlic, onion, radish, carrot, turnip, cucumber, beet, cabbage, tomato, peas.
4.	*Fruits*	: apple, mango, banana, grape, pineapple, custard apple, orange, watermelon.
5.	*Dry fruits*	: walnuts, cashew-nut, raisins.
6.	*Oilseeds*	: peanut, castor, coconut, mustard, sunflower, soybean.
7.	*Spices*	: pepper, chilli, clove, cinnamon, turmeric (*haldi*), ginger, saffron, (kesar).
8.	*Beverages*	: tea, coffee, cocoa.
9.	*Sugar*	: sugarcane, palm.

Fig. 11.8. Various foods from plants.

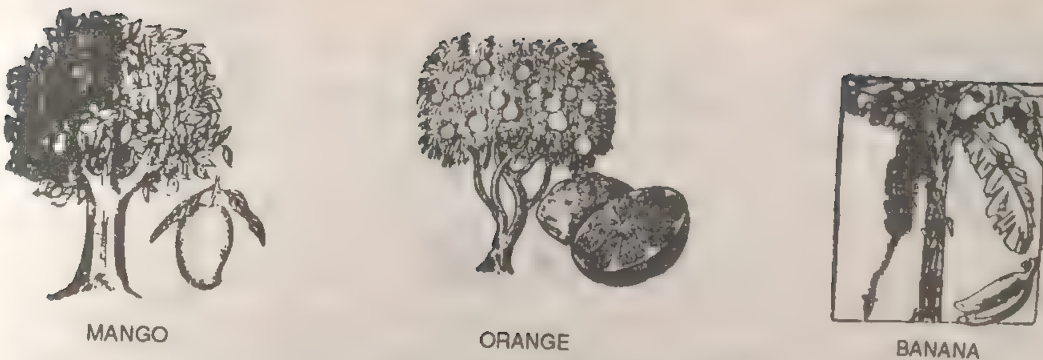


Fig. 11.9. Various fruits from plants

Plants provide us with materials for clothing. Cotton plants produce cotton. Linen and artificial silk are obtained from plant fibres. Coirs, threads and twines are also the gifts of plants. Teak and Sal wood are used for preparing wooden furnitures doors, windows and girders. The thatched roof and partitions are made of plant materials. Bamboo, a kind of grass, has various uses.

Many plants have medicinal importance. Quinine obtained from the bark of *Cinchona* plant is a sure cure for malaria. The magic bullet–*Penicillin* is obtained from a kind of plant called *Penicillium.*

Paper for our writing, is made from the pulp of bamboo and other plants.

We obtain many dyes and scents from plants.

Plants also provide the cheapest source of fuel in the form of fire wood, coal, and coke of different kinds. Coal and coke are nothing else but plants that got buried.

From the centuries old buried plant wealth, we also get precious diamond, the most refined form of carbon, and many other chemicals, such as coal tar.

What about the ornamental value of plants ? We grow them in our rooms and around our homes to make these places beautiful and also to make the surrounding air cooled.

During heavy rains, a lot of soil is carried away with water. The same thing happens when there are strong winds. This is more common with the soils in which there are no plants growing. On the other hand, if there are plants growing in a soil,

Fig. 11.10 Various Oilseeds from plants.

Fig. 11.11

their roots entrap it and do not let it run with water or air currents. The fallen leaves on the grounds also hold the water in the soil as against the strong flow of water.

Among all those substances, which plant gives us, *Oxygen*–the life gas, is the most important. In the absence of oxygen no living being can survive. And the plants give us oxygen in exchange of carbon dioxide, the gas produced by all animals, plants and other living organisms.

Considering all this importance and significance of plants, we need to cultivate them near us, so that, we may conveniently use them or their products.

SUMMARY

Animals are very useful to man. They provide food, silk, wool, leather, honey, lac and many other useful articles.

Insects and birds help in pollination. Birds and many other animals help in dispersal of seeds and fruits.

Plants are of tremendous use to us. They provide us with fruits, vegetables, cloth, oil, spices, medicines and various other products.

Just as there are various useful animals, there are some harmful animals too. Many of these harmful animals live in association with human habitats, causing considerable damage to man and his health. One should be familiar with some of these harmful animals and the nature of damage caused by them in order to be able to take right kind of preventive measures at the right time.

Conservation is not the protection of our animals and plants alone. It includes increasing their population and making their best use also. We must do our bit in the conservation of our wild life and save our beautiful animals from becoming extinct.

QUESTIONS

1. Which of the following products are obtained from plants?

(a) Coconut oil
(b) sago,
(c) jute,
(d) linen,
(e) bee-wax,
(f) wood,
(g) frame of spectacles,
(h) card-board,
(i) coal tar,
(j) looking glass.

2. Name the plant-products you have taken at your breakfast.

3. 'Life of animals will be impossible in the absence of plants' Why ?

4. What is the difference between cultivated and wild plants ?

5. Name three animals around your home which eat plant products, and three animals which feed on other animals or animal product.

6. How do domestic animals differ from wild animals ?

7. What is the importance of animals to plants ?

8. Make a list of plants useful to mankind along with their products.

	Plants	Products
1.	....	....
2.	....	....
3.	....	....
4.	....	....
5.	....	....
6.	....	....
7.	....	....
8.	....	....
9.	....	....
10.	....	....

9. Make a list of uses of the following animals.

1. Cows
2. Hens
3. Lac Insects
4. Silk moths.
5. Honey-bees.
6. Horses.

10. Make a list of uses, the following plants can be put to :

1. Soyabean
2. Coconut
3. Beet root
4. Carrot
5. Wheat
6. Teak
7. Coffee
8. Cotton
9. Sugarcane
10. Mustard.

ACTIVITY

1. Make a collection of various animals products, you come across in your surroundings.

2. Make a album of the various useful plant products.

CHAPTER 12

CONSERVATION OF NATURAL RESOURCES

We all know, that, the life of all living organisms is dependent on nature. Out of all the organisms, man utilises the sources of nature for food, shelter, clothing, water, energy, coal and minerals. He exploits these sources directly or indirectly in the best possible ways.

The nature has the reserve stocks of the supply which man has been utilizing for his survival. The reserve stock of the supply is called the *resources*. As, the resource is being provided by nature (or nature recycling), it can easily be called *natural resources.*

As the life of all organisms depend upon these natural resources, the care has to be taken for, the resources do not get exhausted. If the resources get exhausted, all life on the earth will get disturbed. In order to maintain the balance in nature, it is essential that the natural resources should be preserved and used carefully. This is called *Conservation of natural resources.*

12.1 Natural Resources :

The life of man and other organisms depends upon the availability of the natural resources in nature. The resources are of two types :

(i) Renewable.

(ii) Non-renewable.

The following presentation indicates an idea of the kinds of natural resources :

The renewable sources can be restored in nature after being used ; whereas the non-renewable once utilised, are exhausted forever. Therefore, it is essential to use the natural resources very carefully.

Natural Resources

- Exhaustible
  - Renewable
    1. Water
    2. Soil fertility
    3. Product of oceans
  - Non-renewable
    1. Wild life
    2. Metals.
    3. Minerals coal and oil.
- In-exhaustible
  1. Atomic energy.
  2. Atmosphere
  3. Solar energy (Energy from sun).
  4. Water of oceans and lakes

Man in his effort to get more food, shelter and comfort, for the growing population has been destructive and wasteful. Great forest areas are destroyed without afforestation. This results in soil erosion and floods, causing heavy loss of life and property. Many species of plants and animals have been completely destroyed. Many of these have become extinct.

Yet, man depends upon soil, animals, coal, oil and minerals for the basic necessities of life. However, these are not inexhaustible. Hence, he has recently begun to think of these in terms of his needs of tomorrow.

Man faces two problems. He has to ensure the availability of resources for the growing population. He has also to preserve the natural environment in a state suitable for life.

Soil as a Natural Resource

Soil is a complex mixture of living and non-living materials. It provides anchorage and substance to plants. It is important for the growth of plants. It is the source of minerals.

Soil Erosion and Conservation

Wind and water are very important for the formation of soil. They cause a lot of damage also.

On the summer windy days, you would observe dust-storms. Where is this dust coming from ? It is naturally from the fields and also from the rocks. The wind is thus carrying a lot of top soil with it.

During the rainy season, streams of muddy water are seen running. This muddy water is carrying nothing but the soil with it.

Fig. 12.1 Prevention of wind erosion by planting trees

The carrying away of soil by wind or water is called *soil erosion*.

Soil erosion easily takes place on hilly slopes, because the rain water runs down the slopes very quickly carrying with it a lot of soil. Erosion can also occur on flat grounds which are left open.

Plants do not grow on eroded land. It does not have enough soil to provide the plants with the required materials, such as, mineral salts and water.

We must try to stop the soil erosion, so that our plants may grow on the land. *Soil conservation* is the name given to man's efforts to stop soil erosion. There are several ways of soil conservation.

Small plants, such as grasses, called cover crops may be grown on flat open grounds to stop soil erosion. The roots of these plants hold the ground tightly. When the rain falls, it cannot wash away the soil.

In areas of heavy rainfall, trees may be planted. The roots of these trees will spread far and deep in the soil. They will, thus, help to hold the soil together.

Trees and tall bushes may be planted at the edges of the open fields. The trees and tall bushes act as big walls and save the open fields from the strong winds. The winds, therefore, cannot erode soil from the fields.

Soil erosion on hilly slopes can be checked by cutting 'steps' on the slopes. These steps are called *terraces*. The terraces do not let the water run straight down from the slope. The flow of the water running on the terraces becomes slow. Much soil that is carried by the water is left on the terraces.

Another way to check soil erosion from slopes is to raise the edges of terraces in the form of small 'bunds'. These 'bunds' will not let the rain water and the soil carried by it to drain from the field.

Sometimes narrow steps, called *contours*, are cut on the hill slopes. Trees are planted in these steps. The contours help to slow down the flow of rain water on them.

Cover crops may also be grown on the contours or slopes between terraces to stop soil erosion.

Fig. 12.2 Terrace Farming

Conservation of water

Man has realised the importance of water for a long time. Very recently, he understood the importance of preventing the loss of water resources.

Water can be conserved by holding as much of rain water as possible in the region where it falls, especially in the hills which serves as catchment areas. Many dams have been constructed near catchment areas to retain water. These dams regulate the supply of water to the fields. At the same time, they also regulate the constant flow of clear water in the rivers.

Afforestation of catchment area is necessary because dams alone cannot conserve the desired water reserves. This also reduces silting and prolongs the functional life of the dam.

Much water is polluted by sewage and industrial wastes. Some municipalities have special sewage plans. The sewage is first putrefied and the water alone is released into the river. In many factories, arrangement have been made to filter out the industrial wastes.

People should be educated to use the water resources properly, as majority of people in our country still use polluted water. Water should not be wasted. Taps should be closed if, not in use.

Conservation of Forest

Conservation of forest involves economy in lumbering, prevention of forest fires, control of insects, pests and diseases, planting new trees and preservation of wild animals.

Nearly two-third of a tree is wasted between the time it is cut and the time it is converted into finished product. Sometimes, the better part of the tree is cut into logs, leaving the rest to decay. Forest fires also cause depletion of forests.

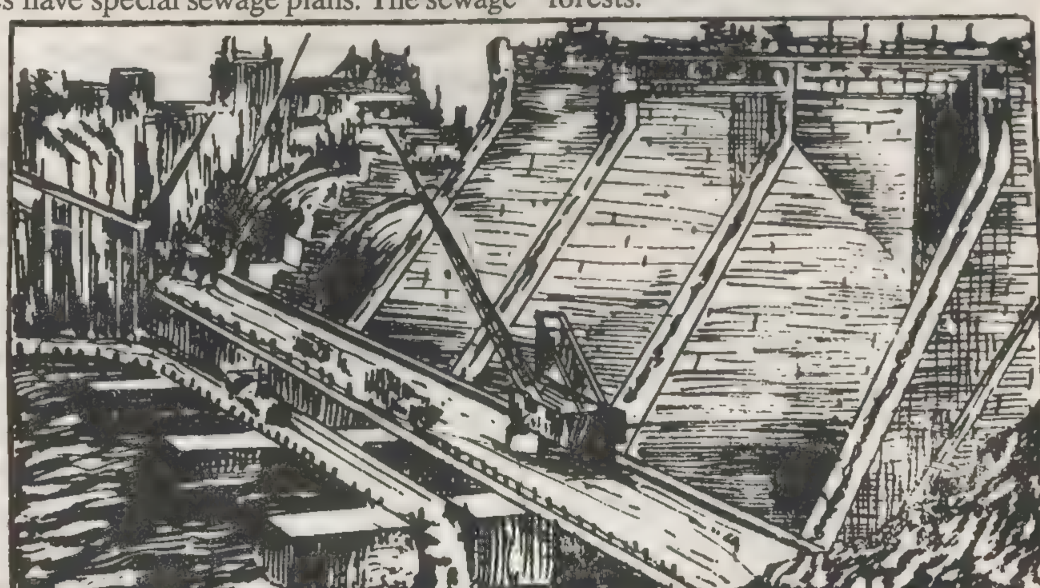


Fig. 12.3 A multipurpose Dam.

Trees removed for timber, fire wood and other purposes should be replaced by planting new ones. Fires and plant diseases should be checked. In recent years, national parks and conservation forests have been established for this purpose.

Conservation of Animals

We often read in the newspapers that the population of most of our animals in the forests is falling. Some years ago, the tiger was a common sight in the forest of *'terai'* and on the outskirts of most of the villages bordering the Madhya Pradesh. Similarly, the lion could be easily seen in the Gir forest in Gujarat. Today these animals are not so easily found in their earlier natural homes. We may have to go deep into the forest and probably would have to use a bait to attract a tiger or a lion. Even then, we may not be sure of seeing the animals. Why is it so ?

Let us give a thought to the natural requirements of these animals. Their natural food is the herbivores like the deer. If man does not disturb, the natural food cycle exists in the forests between flesh-eating carnivores and the plant eating herbivores.

If man disturbs the life in the forest and starts killing the carnivores for their beautiful skin or other parts of their body, or for sport, the number of carnivores will fall. The population of herbivores will increase. They will need more plants to feed themselves. Hence, the plant life in the forests will be in danger. A day may come when the plant life may perish and the herbivores may starve to death. Thus, they may become extinct. Let us consider that man kills the herbivores, such as the deer, for their beautiful skin, for food or for sport. Their falling population will affect the life of the carnivores that feed upon the herbivores. These carnivores may become week. They may start killing domestic cattle and even human beings. Then to defend himself and to protect his cattle, man kills them. Many of these carnivores may die of starvation also. Thus, we have their falling population and a danger for the species to come to an end.

Such activities disturb the *'Balance of Nature'*, which means a more or less constant number of carnivores and herbivores in a particular area along with the vegetation there. We are facing this disturbance in nature and the population of our wild animals is in danger.

Our government is taking much care to protect these animals. There are preserved forests, where these animals can live and roam about freely. There are laws against killing these animals. Recently, an internationally financed programme 'Operation Tiger' has been launched in India to save the tiger from becoming extinct. We must help in protecting our animal life from becoming extinct. Rather we must help in its conservation, which is not only protection of our animals and plant life but also helping to increase their number and using them to our best advantage without upsetting the 'Balance in Nature'.

SUMMARY

There are two kinds of resources : Renewable (soil, water, forest and wild life) and non-renewable (Minerals, oil and coal).

Non-renewable resources once used are lost for-ever. The renewal resources, if misused, may also be lost.

All the renewable resources are interlinked. We must conserve all of them. Methods of conservation are well known, but we must realise that the natural resources must be conserved for our survival ; and to maintain balance in nature.

QUESTIONS

1. What is the difference between re–newable and non-renewable resources ?
2. What steps are recommended to prevent soil erosion ?
3. Why are forests important for mankind ?
4. Discuss how forests can be conserved.
5. What is the role of catchment area ?
6. Make a list of the natural resources to be conserved by us.

(1) ____________ (2) ____________ (3) ____________

(4) ____________ (5) ____________ (6) ____________

7. What do you understand by *Extinct* ?
8. List the different ways by which you can help in conserving water as a resource.
9. Give three examples each of Re-newable and Non-renewable resources.
10. What efforts are being done by our Government for conserving wild life ?

ACTIVITY

1. Make charts for your class
   (a) Explaining, how is man misusing the natural resources (Any two) ?
   (b) Explaining, how can the resources be conserved by your school children ?

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